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Energy Use in Elementary Schools Using Geothermal Heat Pump Systems

Phase One: Survey Results

Prepared for

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UNIVERSITY of LOUISVILLE,
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Executive Summary

Through a four-page questionnaire, information was collected from facilities management at 31 elementary schools at 19 different school districts across the Commonwealth of Kentucky. The only criterion for selection of the elementary schools was that they be either built or extensively renovated between 1998 and 2002. The questions focused on determining how energy usage of schools with geothermal heat pump (GHP) systems in place compares to that of schools with other types of systems. The average Energy Use Index (EUI) of the GHP schools for the period from July 2003 to June 2004 was 48,369 Btu/ft²/yr. The average EUI for the schools with other systems was 65,596 Btu/ft²/yr for the same time period. Both sets of schools are from across the state and across climatic zones. The conclusion of this study with regard to energy use in the schools surveyed is that the GHP systems were performing significantly (about 26% by the numbers reported) better than the other systems on average. There was a high statistical standard deviation in both the GHP and the other schools with regard to the EUI. This may be the subject of future study. In other words, we would like to know why there is such a high variation in the performance of the systems. This information is presented in Tables 6 and 7 (see pages 12 and 13).

The average cost of the heating and cooling system per square foot of conditioned space (noted as mechanical cost/ft²) was reported to be slightly lower for the non-GHP systems than for the GHP systems, averaging about 10% higher. Results also show that, although energy used per student of the GHP schools was less, the energy cost per student was reported to be similar for the GHP schools. This is caused by the lower cost of the natural gas used for heating in the non-GHP schools.

Information was also solicited on a range of other issues affecting energy usage in individual buildings, such as number of occupants, number of computers, temperature settings and times of occupancy. This information was used to try to establish a comparison between the loads on the systems. The answers given were translated into a series of scores, shown in Table 8 (see page 16). The non-GHP schools do not appear to be significantly more loaded than the GHP schools in the study.

The variables for these schools are run through the algorithm of Portfolio Manager, an Energy Star® program, and the resulting number for predicted usage is compared to the results with the numbers for actual usage. The GHP schools appear to correlate to the data for typical school buildings nationally better than the non-GHP schools in Table 9 (see page 18).

Maintenance issues were collected in a short answer format. It does not appear that there has been more or less maintenance or repair required with the GHP systems than with the other systems. The results are shown in Tables 10 and 11 (see pages 21 and 22).

Background

The purpose of this study is to compare the energy usage of elementary school buildings built or fully renovated between 1998 and 2002, in order to determine if the geothermal heat pump (GHP) systems installed are performing as well compared to other schools of similar age. A committee was formed to determine the manner in which the study would be conducted (see names in **Appendix A**). A two-phase study was planned, where general information about a broad group of elementary schools would be collected in the first phase, followed by more detailed investigations into a subset of those schools. This second phase would only be conducted if the first phase shows poor energy performance of the GHP schools. The contract language for the study, as agreed upon by the Kentucky Office of Energy Policy (KOEP) and the Kentucky Pollution Prevention Center (KPPC), is included in **Appendix A**. Phase one will be concluded with this report.

For the purposes of this report, 37 four-page questionnaires were sent out, each one soliciting information about a specific school. Thirty-one schools returned the surveys, 22 with geothermal and 9 with other types of heating and cooling systems. The questionnaire was developed with the input of the committee. The survey itself is included as **Appendix B** of this report. *The 37 schools surveyed appear from records at the Kentucky Department of Education to be nearly all of the elementary schools either built or extensively renovated during the five-year period in our parameters.* The annual energy cost for June 2003 to July 2004 and information about the size and type of the building were collected. In addition, to determine whether the geothermal heat pump systems require more maintenance, information was collected about scheduled and unplanned maintenance for all of the systems. It was also determined that heating and cooling set temperatures were another key consideration, and this information was collected via telephone. Testimony from managers of the facility was also recorded in some cases. All of the data collected is found in **Appendix C**, which shows the full database record for each of the schools.

Upon review of the results, James Bush, an engineer with the KOEP, pointed out that ventilation rates in the buildings are another key factor which would contribute to differences in energy use. Investigating this further should be part of Phase Two of the study.

Much of the information collected, such as whether energy management equipment (i.e. digital controls, energy recovery wheels, economizers) was included in the building heating and cooling system, was very generic and only accounted for in the arbitrary scoring system shown in the **System Comparison Matrix** table (Table 8, see page 16). A benchmarking tool from Energy Star® called Portfolio Manager incorporates a more sophisticated method of comparing buildings, where many of the factors are inserted into a weighted algorithm. This method does not consider ventilation flow rates or energy management equipment, but does consider the relative importance of operating hours, kitchen usage, climate differences, number of computers and whether or not mechanical ventilation exists in the building.

Two existing studies were examined in the preliminary stages of this study. One conducted by Kentucky Utilities Company, *School Life Cycle Cost Studies and Case Histories*, is a compilation of work done by various companies from 1995 to 1999. This study looked at the life cycle costs of GHP schools versus non-GHP schools, based on energy usage, square footage,

estimates of maintenance costs and estimates of how these costs will increase over a 20-year time period. The second study was done by Oak Ridge National Laboratory, *Geothermal Heat Pumps in K-12 Schools*, and was released in 2000. It may serve as a model for Phase Two of this study. The analysis used in that report included the use of software models, detailed information about the heat rejection loops, the soil characteristics, the ventilation rates and many other factors.

Schools

The raw data received from each school is provided in **Appendix C** (see page 32). The following tables summarize the data collected for this study. Table 1 (see next page) provides information about the sizes of the schools in terms of student bodies, number of staff and the area of the conditioned space of the buildings. Table 2 (see page 6) shows the responses to the question “Type of heating and cooling system.” This information was solicited in short answer form only, and investigating more detail could be part of Phase Two of the study. The length of the school year and the number of hours in a school day are reported in Table 3 (see page 7).

In Table 4 (see page 8) information collected about the length of the heating and cooling seasons reported at the schools, the temperature set-points and the normal heating and cooling *degree days* is provided. Degree days are found by adding the difference in the daily temperatures from 65°F that occurs each day of the year. For example, if every day in April the average temperature for the day was 70°F, there would be (5° x 31 days) 155 cooling degree days cumulative over the month. The heating degree days are counted when the average daily temperature is below 65°F. This can be done for the year to get the annual heating and cooling degree days. The reference data is from climatic norms for closest weather stations across Kentucky as recorded from 1971 to 2000 by the National Oceanic and Atmospheric Administration (NOAA).

Table 5 (see page 10) provides the ages of the schools surveyed and the dates of the renovations. Eighteen of the schools were built new between 1998 and 2002 and the others were renovated. Of the renovated buildings, six also received additions.

Table 1: School Size

County	School	GHP	Staff	Students	ADA	Heated Space (ft ²)	Cooled Space (ft ²)
Allen Co.	Allen Co. Primary	Yes	116	856	820	95,516	95,516
Barren Co.	Park City Elementary	Yes	55	332	309	53,989	51,000
Barren Co.	Red Cross Elementary	Yes	80	695	681	64,950	61,950
Boone Co.	Erpenbeck Elementary	No	183	1030	891	78,800	78,800
Boone Co.	North Pointe Elementary	No	152	745	611	75,800	75,800
Boyd Co.	Cannonsburg Elementary	Yes	60	301	282	43,130	46,130
Carter Co.	Heritage Elementary	Yes	65	437	407	63,732	63,732
Christian Co.	Crofton Elementary	Yes	53	282	257	61,500	61,500
Christian Co.	Sinking Fork Elementary	Yes	64	331	302	59,364	59,364
Clay Co.	Burning Springs Elementary	Yes	46	407	377	64,000	64,000
Daviess Co.	East View Elementary	Yes	76	450	450	74,249	74,249
Green Co.	Greensburg Elementary	No	67	450	427	69,800	69,800
Jefferson Co.	Chancey Elementary	No	72	759	732	76,000	64,600
Jefferson Co.	Foster Elementary	No	74	620	611	78,000	78,000
Jessamine Co.	Wilmore Elementary	Yes	50	570	540	66,450	66,450
Johnson Co.	Highland Elementary	No	70	461	445	58,209	58,209
Laurel Co.	Camp Ground Elementary	Yes	37	307	273	34,000	34,000
Laurel Co.	Hazel Green Elementary	Yes	42	309	284	43,385	43,385
Laurel Co.	Johnson Elementary	Yes	35	272	249	34,000	34,000
Magoffin Co.	Salyersville Grade School	No	80	549	521	80,008	80,008
Martin Co.	Eden Elementary	Yes	94	455	419	58,520	58,520
Pulaski Co.	Eubank Elementary	Yes	47	291	275	37,570	37,570
Pulaski Co.	Nancy Elementary	Yes	54	349	333	42,044	42,044
Pulaski Co.	Pulaski Elementary	Yes	85	682	652	61,678	61,678
Pulaski Co.	Shopville Elementary	Yes	56	374	356	47,906	47,906
Pulaski Co.	Woodstock Elementary	Yes	31	150	142	24,133	24,133
Shelby Co.	Painted Stone Elementary	Yes	80	602	580	76,000	76,000
Warren Co.	Richardsville Elementary	Yes	69	472	443	45,306	45,306
Warren Co.	Richpond Elementary	Yes	87	733	696	58,622	58,622
Warren Co.	Rockfield Elementary	No	77	554	532	62,848	62,848
Washington Co.	No. Washington Elementary	No	81	499	480	60,125	60,125

Table 2: School Heating and Cooling System

County	School	Type
Allen Co.	Allen Co. Primary	GHP
Barren Co.	Park City Elementary	GHP
Barren Co.	Red Cross Elementary	GHP
Boone Co.	Erpenbeck Elementary	2 gas hot water boilers. 2 electric water chillers
Boone Co.	North Pointe Elementary	2 gas boilers, 3 air cooled elect. chillers
Boyd Co.	Cannonsburg Elementary	GHP and Electric HVAC
Carter Co.	Heritage Elementary	GHP
Christian Co.	Crofton Elementary	GHP
Christian Co.	Sinking Fork Elementary	GHP
Clay Co.	Burning Springs Elementary	GHP
Daviess Co.	East View Elementary	GHP
Green Co.	Greensburg Elementary	Heating with four pipe - Cooling with chillers
Jefferson Co.	Chancey Elementary	VAV with gas heat
Jefferson Co.	Foster Elementary	two pipe fan coils, 6-AHU's, 3 boilers, 2 chillers
Jessamine Co.	Wilmore Elementary	GHP - 4 AHU's 10 to 15 tons
Johnson Co.	Highland Elementary	Boilers, classroom units with DX cooling
Laurel Co.	Camp Ground Elementary	GHP
Laurel Co.	Hazel Green Elementary	GHP
Laurel Co.	Johnson Elementary	GHP
Magoffin Co.	Salyersville Grade School	WSHP with chiller, electric boiler for heat
Martin Co.	Eden Elementary	GHP System
Pulaski Co.	Eubank Elementary	GHP/rooftop AC
Pulaski Co.	Nancy Elementary	GHP
Pulaski Co.	Pulaski Elementary	GHP w/ two make-up air units
Pulaski Co.	Shopville Elementary	GHP/rooftop units 2 make-up air units
Pulaski Co.	Woodstock Elementary	GHP
Shelby Co.	Painted Stone Elementary	GHP 78 classroom heat pump units
Warren Co.	Richardsville Elementary	Geothermal since 1998
Warren Co.	Richpond Elementary	GHP
Warren Co.	Rockfield Elementary	RTU-gas
Washington Co.	No. Washington Elementary	Chiller and rooftop AC, heat pump and hot water heat

Table 3: School Operating Schedule

County	School	Dates of School Year	Daily Occupancy
Allen Co.	Allen Co. Primary	Aug.-May	7.5
Barren Co.	Park City Elementary	Aug.-May	7
Barren Co.	Red Cross Elementary	Aug.-May	7
Boone Co.	Erpenbeck Elementary		9.5
Boone Co.	North Pointe Elementary		9.5
Boyd Co	Cannonsburg Elementary	Aug. 2-May 24	8
Carter Co.	Heritage Elementary	Aug.-May	8
Christian Co.	Crofton Elementary	Aug.-May	7
Christian Co.	Sinking Fork Elementary	Aug.-May	7
Clay Co.	Burning Springs Elementary	Aug.-May	8.75
Daviess Co.	East View Elementary	Aug. 11-May 17	7
Green Co.	Greensburg Elementary		8
Jefferson Co.	Chancey Elementary	all year	8.5
Jefferson Co.	Foster Elementary	mid. Aug.-end May	8.5
Jessamine Co.	Wilmore Elementary	?	7
Johnson Co.	Highland Elementary	Aug. to May	8
Laurel Co.	Camp Ground Elementary	Aug.-May	9
Laurel Co.	Hazel Green Elementary	Aug.-May	9
Laurel Co.	Johnson Elementary	Aug.-May	9
Magoffin Co.	Salyersville Grade School	Aug. 1-May30	7.5
Martin Co.	Eden Elementary	Aug. -May	8.5
Pulaski Co.	Eubank Elementary	Aug. 1-June 15	9.5
Pulaski Co.	Nancy Elementary	Aug. 1-June15	9.5
Pulaski Co.	Pulaski Elementary	Aug. 1-June 15	9.5
Pulaski Co.	Shopville Elementary	Aug. 1-June 15	9.5
Pulaski Co.	Woodstock Elementary	Aug. 1-June 15	9.5
Shelby Co.	Painted Stone Elementary	8-11 to 5-24	12
Warren Co.	Richardsville Elementary	Aug. 5-May 20	7
Warren Co.	Richpond Elementary	Aug. 5 - May 20	7
Warren Co.	Rockfield Elementary	Aug. 5-May 20	7
Washington Co.	No. Washington Elementary		9.5

Table 4: School Climate and Temperature Parameters

County	School	Annual Cooling Days ¹	Annual Heating Days ¹	Heat Set Point ² (°F)	Cool Set Point ² (°F)	Normal Annual Cooling Degree Days ³	Normal Annual Heating Degree Days ³
Allen Co.	Allen Co. Primary	182	183	72	68	1362	3831
Barren Co.	Park City Elementary	182	183	68-50	72-95	1509	3862
Barren Co.	Red Cross Elementary	182	183	68-50	72-95	1509	3862
Boone Co.	Erpenbeck Elementary	240	125	72	72	1064	5148
Boone Co.	North Pointe Elementary	240	125	72	72	1064	5148
Boyd Co.	Cannonsburg Elementary	90	195			943	5217
Carter Co.	Heritage Elementary	182	183	72	72	1565	5228
Christian Co.	Crofton Elementary	183	182	72	72	1433	4298
Christian Co.	Sinking Fork Elementary	187	178	68-70	70	1433	4298
Clay Co.	Burning Springs Elementary	182	183			901	4766
Daviess Co.	East View Elementary	215	150	72-55	?	1565	4159
Green Co.	Greensburg Elementary	183	182	72	70	1312	4451
Jefferson Co.	Chancey Elementary	182	183	69-73	73-77	1443	4352
Jefferson Co.	Foster Elementary	182	183	73-69	73-77	1443	4352
Jessamine Co.	Wilmore Elementary	182	183			1154	4713
Johnson Co.	Highland Elementary	182	183			1300	4427
Laurel Co.	Camp Ground Elementary	183	182	70	70	1099	4373
Laurel Co.	Hazel Green Elementary	183	182	70	70	1099	4374
Laurel Co.	Johnson Elementary			70	70	1099	4374
Magoffin Co.	Salyersville Grade School	195	166	72	72	1300	4427
Martin Co.	Eden Elementary	215	150	70	70	888	5096
Pulaski Co.	Eubank Elementary	182	183	72-60	74-80	1081	4358
Pulaski Co.	Nancy Elementary	182	183	72-60	74-80	1081	4358

County	School	Annual Cooling Days ¹	Annual Heating Days ¹	Heat Set Point ² (°F)	Cool Set Point ² (°F)	Normal Annual Cooling Degree Days ³	Normal Annual Heating Degree Days ³
Pulaski Co.	Pulaski Elementary	182	183	72-60	74-80	1081	4358
Pulaski Co.	Shopville Elementary	182	183	72-60	74-80	1081	4358
Pulaski Co.	Woodstock Elementary	216	150	72-60	74-80	1081	4358
Shelby Co.	Painted Stone Elementary	183	182	72	72	981	5219
Warren Co.	Richardsville Elementary					1413	4243
Warren Co.	Richpond Elementary					1413	4243
Warren Co.	Rockfield Elementary					1413	4243
Washington Co.	No. Washington Elementary	216	150	74	70	1136	4497

1. These are based on the reported months when cooling equipment is operating in the building and when heating equipment is operating in the building from the surveys.
2. Where two numbers are given, this indicates reported summer and winter thermostatic set-backs from the survey.
3. Degree Day Data provided from 65° F base at selected bases across Kentucky from National Oceanic and Atmospheric Administration climate norms from 1971-2000. The county where the weather base is located was correlated with the county where the school was located. A degree day is defined as the difference between the average daily temperature (calculated by adding the maximum and minimum temperatures then dividing by 2) and some base temperature value.

Table 5: School Age

County	School	Age of School
Allen Co.	Allen Co. Primary	2001 (4 years)
Barren Co.	Park City Elementary	2001 (4 years)
Barren Co.	Red Cross Elementary	1999 (6 years)
Boone Co.	Erpenbeck Elementary	1998 (7 years)
Boone Co.	North Pointe Elementary	2000 (5 years)
Boyd Co	Cannonsburg Elementary	1962, 1985, 2000
Carter Co.	Heritage Elementary	2000 (5 years)
Christian Co.	Crofton Elementary	2002 (3 years)
Christian Co.	Sinking Fork Elementary	1998 (7 years)
Clay Co.	Burning Springs Elementary	1958, renovation 2002
Daviess Co.	East View Elementary	1998 (8 years)
Green Co.	Greensburg Elementary	2002 (3 years)
Jefferson Co.	Chancey Elementary	2002 (3 years)
Jefferson Co.	Foster Elementary	2000 (5 years)
Jessamine Co.	Wilmore Elementary	2000 (5 years)
Johnson Co.	Highland Elementary	1998 (7 years)
Laurel Co.	Camp Ground Elementary	1962, renovation 2001
Laurel Co.	Hazel Green Elementary	1960, revovation 2002
Laurel Co.	Johnson Elementary	1962, renovation in 2001
Magoffin Co.	Salyersville Grade School	2002 (3.5 years)
Martin Co.	Eden Elementary	2001 (4 years)
Pulaski Co.	Eubank Elementary	1956, 1998 addition
Pulaski Co.	Nancy Elementary	1959, 1998 addition
Pulaski Co.	Pulaski Elementary	1962, renovation in 2001
Pulaski Co.	Shopville Elementary	1959, renovation 1998
Pulaski Co.	Woodstock Elementary	1957, 1998 renovation
Shelby Co.	Painted Stone Elementary	2002 (3 years)
Warren Co.	Richardsville Elementary	‘49, ‘79, ‘94, ‘96, ‘98
Warren Co.	Richpond Elementary	1952, ‘98, ‘02
Warren Co.	Rockfield Elementary	1974, 2002 addition
Washington Co.	No. Washington Elementary	1998 (6 years)

Indices

The tables presented in this section contain indices that are useful for comparing buildings. Table 6 (see next page) lists the schools in order of the lowest Energy Usage Index (EUI, Btu/ft²/yr) and also provides the Energy Cost Index (ECI, \$/ft²/yr), mechanical system cost/ft², and students/100 ft² of conditioned space. The EUI, as well as all of the other indices, use the entire energy usage and the entire energy cost for the entire building.

From Table 6, the EUI for Park City Elementary with a GHP system is estimated to be 6,646 Btu/ft²/yr. This is considered to be extremely low. Similarly, the estimated EUI for Painted Stone Elementary with GHP system and Erpenbeck Elementary with conventional systems are estimated to be 95,265 Btu/ft²/yr and 100,027 Btu/ft²/yr respectively and considered to be extremely high. The above schools are not considered in the estimation of average values and standard deviation.

The average EUI of the GHP schools studied for this study was 48,396 Btu/ft²/yr. The average EUI of the non-GHP schools studied for this study was 65,596 Btu/ft²/yr. Standard deviations of EUI for schools with GHP systems and conventional systems were computed to determine the degree of dispersion in the dataset. The standard deviations for schools with GHP systems and conventional systems were 13,031 Btu/ft²/yr and 12,481 Btu/ft²/yr respectively. Thus, although the EUI indicates that on average the GHP schools performed better, there was a greater variation in the results for the GHP schools.

As shown in Table 6, on a square-foot basis, the GHP schools were found to have a slightly lower annual energy cost, about \$0.94/ft² versus \$1.00/ft². Variations in summer versus winter costs were not studied since the survey question only asked for a single annual total for energy use and cost. Investigating this should be part of Phase Two of this study.

In Table 7 (see page 13), the schools are ranked in order of the annual energy usage/student. The annual energy cost/student, mechanical system cost/student and the conditioned space/student are provided. All of the above performance measures use the Average Daily Attendance (ADA) for the number of students. Table 7 shows the energy use per student was lower for the GHP schools on average by about 12%, but energy cost per student was found to be higher for GHP schools due to the higher price of electrical energy versus natural gas.

There may be interest in comparing the schools in other ways. This can be easily done using the database created for the study. For other comparisons using the data collected, contact Sieglinde Kinne at KPPC (502-852-1566) or e-mailing s.kinne@louisville.edu.

Table 6: Energy Use Index**Schools With Geothermal Heat Pump Systems**

EUI (Btu/ft²/yr)	School	ECI (\$/ft²/yr)	Mechanical Cost/ft²	Student/ 100 ft²
6,646	<i>Park City Elementary</i>	\$1.27	\$11.33	0.57
22,800	Cannonsburg Elementary	\$0.97		0.65
27,359	Red Cross Elementary	\$0.86	\$9.21	1.05
38,014	East View Elementary	\$0.67		0.61
40,600	Crofton Elementary	\$0.56	\$12.67	0.42
42,037	Eden Elementary	\$0.82	\$18.13	0.72
43,378	Richpond Elementary	\$1.21		1.19
43,632	Pulaski Elementary	\$0.55	\$20.00	1.06
45,230	Burning Springs Elementary	\$0.81		0.59
45,875	Allen Co. Primary	\$0.96	\$21.61	0.86
47,734	Shopville Elementary	\$0.82	\$18.00	0.74
49,357	Nancy Elementary	\$0.85	\$18.00	0.79
50,110	Heritage Elementary	\$0.76	\$17.10	0.64
50,356	Eubank Elementary	\$0.87	\$18.00	0.73
51,622	Hazel Green Elementary	\$0.92	\$15.18	0.65
51,956	Woodstock Elementary	\$0.91	\$18.00	0.59
52,374	Wilmore Elementary	\$0.79	\$16.07	0.81
52,582	Sinking Fork Elementary	\$1.37	\$10.62	0.51
62,312	Richardsville Elementary	\$1.55		0.98
65,583	Johnson Elementary	\$1.15	\$17.63	0.73
84,477	Camp Ground Elementary	\$1.38	\$17.54	0.80
95,265	<i>Painted Stone Elementary</i>	<i>\$1.17</i>	<i>\$21.00</i>	<i>0.76</i>
48,369	<i>average *</i>	\$0.94	\$16.48	0.75
13,031	<i>standard deviation</i>	\$0.27	\$3.57	0.19

* Schools shown in italics were not used to calculate average or standard deviation of EUI or ECI

Schools With Conventional Systems

EUI (Btu/ft²/yr)	School	ECI (\$/ft²/yr)	Mechanical Cost/ft²	Student/ 100 ft²
55,552	Salyersville Grade School	\$0.93		0.65
55,728	Chancey Elementary	\$0.89	\$13.06	0.96
55,961	Greensburg Elementary	\$0.73	\$10.94	0.61
62,349	Foster Elementary	\$0.87	\$12.18	0.78
62,430	Rockfield Elementary	\$1.23		0.85
63,082	No. Washington Elementary	\$1.19	\$18.84	0.80
80,825	Highland Elementary	\$0.93		0.76
88,844	North Pointe Elementary	\$1.23	\$16.06	0.81
100,027	<i>Erpenbeck Elementary</i>	<i>\$1.50</i>	<i>\$18.86</i>	<i>1.13</i>
65,596	<i>average *</i>	\$1.00	\$14.99	0.82
12,481	<i>standard deviation</i>	\$0.19	\$3.43	0.16

26%	Data Comparison (GHP vs. Conventional)	6%	-10%	8%
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Table 7: Student Indices (Average Daily Attendance)

Schools With Geothermal Heat Pump Systems

Energy Use (MMBtu/ Student/yr)	School	ft²/Student	Energy Cost (\$/Student/yr)	Mechanical Cost/Student
2.61	Red Cross Elementary	95.37	\$82	\$879
3.49	Cannonsburg Elementary	152.94	\$149	
3.65	Richpond Elementary	84.23	\$102	
4.13	Pulaski Elementary	94.60	\$52	\$1,892
5.34	Allen Co. Primary	116.48	\$112	\$2,518
5.87	Eden Elementary	139.67	\$114	\$2,532
6.23	Nancy Elementary	126.26	\$107	\$2,273
6.27	East View Elementary	165.00	\$111	
6.37	Richardsville Elementary	102.27	\$158	
6.42	Shopville Elementary	134.57	\$110	\$2,422
6.44	Wilmore Elementary	123.06	\$97	\$1,978
6.88	Eubank Elementary	136.62	\$119	\$2,459
7.68	Burning Springs Elementary	169.76	\$137	
7.85	Heritage Elementary	156.59	\$120	\$2,678
7.89	Hazel Green Elementary	152.76	\$141	\$2,319
8.83	Woodstock Elementary	169.95	\$154	\$3,059
8.96	Johnson Elementary	136.55	\$157	\$2,407
9.72	Crofton Elementary	239.30	\$135	\$3,033
10.34	Sinking Fork Elementary	196.57	\$270	\$2,088
10.52	Camp Ground Elementary	124.54	\$171	\$2,185
<i>12.20</i>	<i>Park City Elementary</i>	<i>174.72</i>	<i>\$223</i>	<i>\$1,980</i>
<i>12.48</i>	<i>Painted Stone Elementary</i>	<i>131.03</i>	<i>\$153</i>	<i>\$2,752</i>
7.3	average*	141.9	\$135.18	\$2,321
2.7	standard deviation	36.0	\$46.22	\$504

* Schools shown in italics were not used to calculate average or standard deviation of Energy Use or Energy Cost

Schools With Conventional Systems

Energy Use (MMBtu/ Student/yr)	School	ft²/Student	Energy Cost (\$/Student/yr)	Mechanical Cost/Student
5.79	Chancey Elementary	103.83	\$92	\$1,356
7.38	Rockfield Elementary	118.14	\$145	
7.90	No. Washington Elementary	125.26	\$150	\$2,360
7.96	Foster Elementary	127.66	\$111	\$1,555
8.53	Salysersville Grade School	153.57	\$142	
8.85	Erpenbeck Elementary	88.44	\$133	\$1,668
9.15	Greensburg Elementary	163.47	\$120	\$1,788
10.20	Highland Elementary	131.57	\$121	
11.02	<i>North Pointe Elementary</i>	124.06	\$152	\$1,992
8.5	average*	126.2	\$129.56	\$1,787
1.5	standard deviation	22.8	\$20.14	\$353

15%	Data Comparison (GHP vs. Conventional)	-12%	-4%	-30%
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System Comparison – Scoring

A scoring system representing loads on the system was created in order to compare different factors that might affect annual energy usage of the buildings. From the information collected about the schools, four categories were made and given a value range of 1 to 5. In cases where a school did not fall neatly into one of the scores, judgments were made and noted on the comments in **Appendix C** for each school. *Note: The scoring represents factors that will increase the EUI, not how the building energy use is managed. For the purposes of this comparison, increased loads count in favor of higher scores.*

These scores should be used with the understanding that the factors discussed are not weighted based on the degree to which they affect energy usage. A web-based database, Portfolio Manager, developed by the federal Energy Star® program provides a more sophisticated way to score and compare buildings. This program uses Commercial Building Energy Consumption Survey (CBECS) data to fit a curve which predicts energy usage based on a number of factors. The data collected in this survey was insufficient to generate scores for these buildings in Portfolio Manager. However, the algorithm used by Portfolio Manager is discussed later in this report.

Scores

- **Scheduling:** This score incorporates occupancy times of the building and whether the school indicated that there were set-back temperatures in place for unoccupied periods. Systems score higher if the hours of use were indicated to be long and/or if there were no setbacks indicated, since this would cause the energy bill to be higher.
 - 1 – 7 to 8 hour days, 72° summer and 68° winter settings with setbacks
 - 3 – 8 to 9 hour days, no setbacks
 - 5 – Greater than 9 hour days, weekend activities and/or all-year occupancy
- **Building Characteristics:** This score incorporates information about the type of windows, the wall and roof construction and the age of the original structure. Systems score higher if buildings are less modern or efficient, since this will make the heating, ventilating and air conditioning (HVAC) load larger.
 - 1 – Whole building is new, extra attention paid to efficiency
 - 2 – Whole building new, standard construction
 - 3 – Only part of the building new but all renovated
 - 4 – Older building completely renovated
 - 5 – Only part of building renovated
- **Loads:** Systems score higher for having large numbers of ancillary loads, higher if the occupancy index is higher, and higher if the outdoor lights are included in the energy figure. This is based on a presumption that the effect of higher usage (more doors opening, more plug loading, more kitchen energy use, etc...) in the building is more dominant than the effect of the thermal load as a result of metabolic activities generated by bodies, which would tend to decrease the energy used in the heating season (most of the school year in Kentucky).
 - 1 – Low numbers of ancillary loads (count less than 100) and/or energy figure does not include outdoor lights. Occupancy index under 0.75 people/100 ft².

- 3** – Ancillary loads count 0 to 150 and/or energy figure includes outdoor lights. Occupancy index between 0.75 and 1.0 occupants/100 ft².
 - 5** – Many ancillary loads (count greater than 150) and/or energy figure includes outdoor lights. Occupancy index over 1.0 occupants/100 ft².
- **Heating Degree Days:** Information on the climatic normals from 1971 to 2000 as collected by the National Oceanic and Atmospheric Administration in terms of Heating and Cooling Degree Days (HDD and CDD) has been included for each school. Only the Heating Degree Days were compared here for simplicity and because records indicate that in Kentucky heating is the dominant energy use in school buildings.
 - 1** – Heating degree days (HDD) less than 4,000
 - 2** – HDD greater than 4,000
 - 3** – HDD less than 4,400
 - 4** – HDD greater than 4,400
 - 5** – HDD greater than 5,000

Table 8: System Comparison Matrix

EUI	HVAC System	School	Scheduling	Building Characteristics	Loads	Heating Degree Days
6,646	GHP	Park City Elementary	1	2	1	1
22,800	GHP	Cannonsburg Elementary	3	5	3	5
27,359	GHP	Red Cross Elementary	1	2	5	1
38,014	GHP	East View Elementary	1	2	1	1
40,600	GHP	Crofton Elementary	1	2	1	1
42,037	GHP	Eden Elementary	3	2	1	5
43,378	GHP	Richpond Elementary	1	5	5	1
43,632	GHP	Pulaski Elementary	5	4	5	3
45,230	GHP	Burning Springs Elementary	5	4	1	5
45,875	Conv.	Allen Co. Primary	1	1	3	1
47,734	GHP	Shopville Elementary	5	4	3	3
49,357	GHP	Nancy Elementary	5	3	3	3
50,110	GHP	Heritage Elementary	3	2	3	5
50,356	GHP	Eubank Elementary	3	3	1	3
51,622	GHP	Hazel Green Elementary	3	4	1	3
51,956	GHP	Woodstock Elementary	5	4	1	3
52,374	GHP	Wilmore Elementary	1	2	3	3
52,582	GHP	Sinking Fork Elementary	1	2	1	1
55,552	Conv.	Salyersville Grade School	1	2	5	3
55,728	Conv.	Chancey Elementary	5	1	5	3
55,961	Conv.	Greensburg Elementary	1	1	1	3
62,312	GHP	Richardsville Elementary	1	5	3	1
62,349	Conv.	Foster Elementary	3	2	3	3
62,430	Conv.	Rockfield Elementary	1	5	3	1
63,082	Conv.	No. Washington Elementary	5	1	3	3
65,583	GHP	Johnson Elementary	3	4	1	3
80,825	Conv.	Highland Elementary	3	3	3	4
95,265	GHP	Painted Stone Elementary	5	1	3	5
100,027	Conv.	Erpenbeck Elementary	5	1	5	5

Portfolio Manager Algorithm

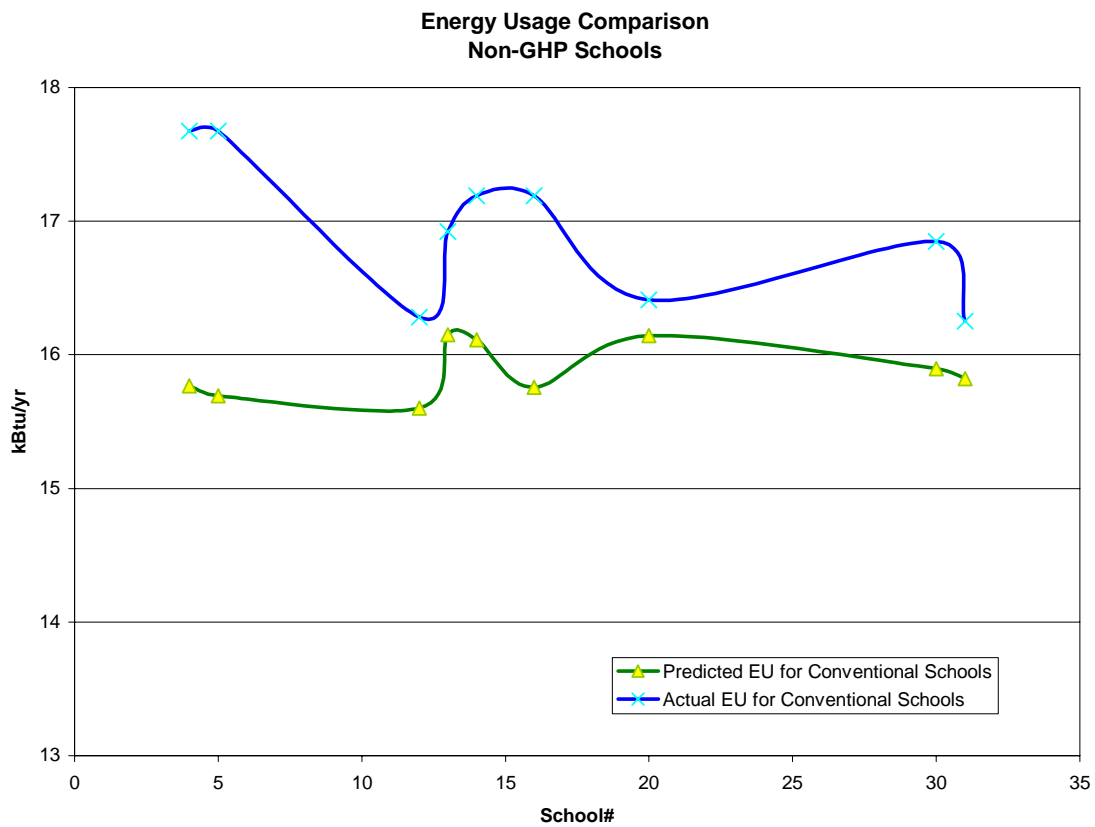
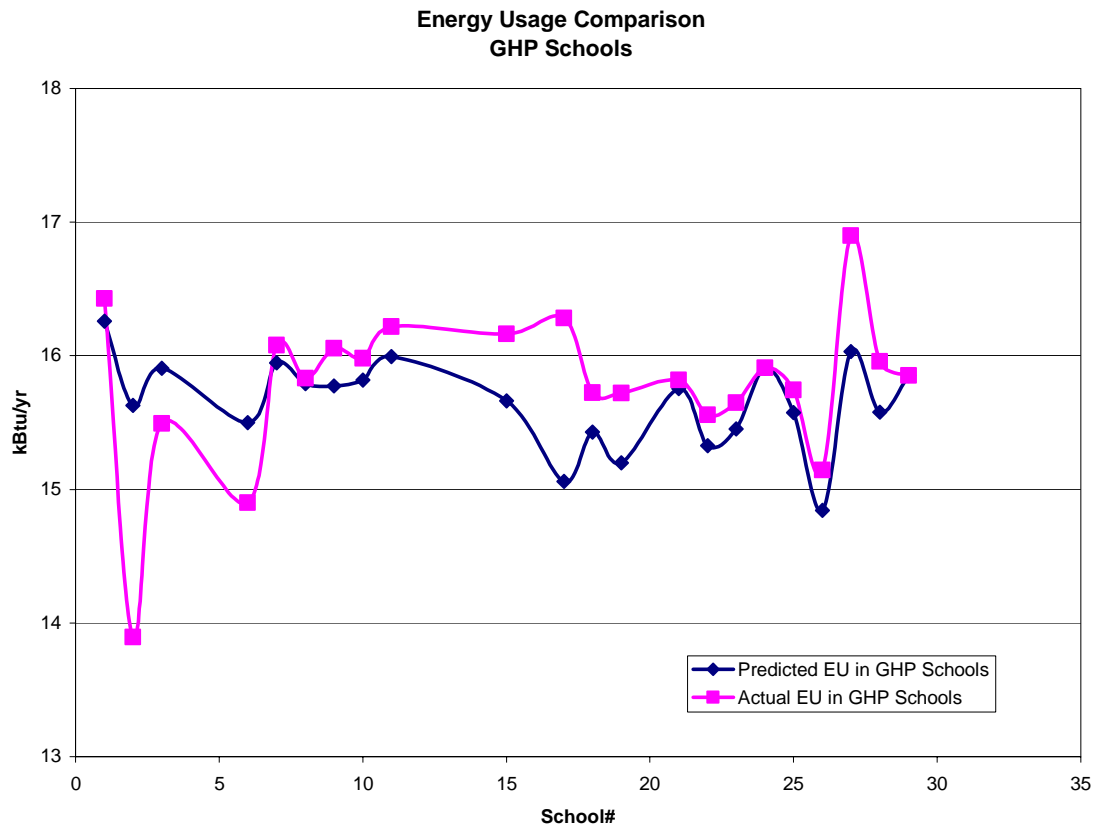
The web-based database, Portfolio Manager, developed by the federal Energy Star® program provides a more sophisticated way to score and compare buildings. This program uses Commercial Buildings Energy Consumption Survey (CBECS) data to fit a curve which predicts energy usage based on a number of factors. The data collected in this survey was insufficient to generate scores for these buildings in Portfolio Manager, since the annual total for energy usage was the only data collected, and the program requires monthly data. However, the algorithm used by Portfolio Manager is provided in a Technical Description of the program. This Technical Description can be found on the Energy Star® web site at

http://www.energystar.gov/ia/business/evaluate_performance/tech_desc_k12_04.pdf

This algorithm was used to generate a number referred to in the Description as the Actual EU and a number referred to as the Predicted EU. This result uses all of the weighted variables including adjustments for climatic norms. One step that was not able to be replicated was normalization for the actual weather at the buildings at the time for which the energy usage data was collected. Nevertheless, the comparison between the Actual EU and the Predicted EU can be interpreted as relating to the relative energy performance of the buildings. These results are compared in Table 9 (see next page). Two charts which follow show the correlation between the Actual EU and the Predicted EU for GHP and non-GHP schools. Interestingly, the GHP schools seem to correlate to the CBECS data much better than the non-GHP schools.

Table 9: Portfolio Manager Algorithm Results

School Number	School	County	System	Predicted EU	Actual EU	Performance Comparison
1	Allen Co. Primary	Allen Co.	GHP	16.2575	16.4279	1.04%
2	Park City Elementary	Barren Co.	GHP	15.6301	13.8934	-12.50%
3	Red Cross Elementary	Barren Co.	GHP	15.9069	15.4934	-2.67%
4	Erpenbeck Elementary	Boone Co.	Conv.	15.7675	17.6736	10.79%
5	North Pointe Elementary	Boone Co.	Conv.	15.6924	17.6744	11.21%
6	Cannonsburg Elementary	Boyd Co.	GHP	15.5003	14.9017	-4.02%
7	Heritage Elementary	Carter Co.	GHP	15.9456	16.0796	0.83%
8	Crofton Elementary	Christian Co.	GHP	15.7910	15.8335	0.27%
9	Sinking Fork Elementary	Christian Co.	GHP	15.7730	16.0568	1.77%
10	Burning Springs Elementary	Clay Co.	GHP	15.8168	15.9813	1.03%
11	East View Elementary	Daviess Co.	GHP	15.9942	16.2178	1.38%
12	Greensburg Elementary	Green Co.	Conv.	15.6019	16.2810	4.17%
13	Chancey Elementary	Jefferson Co.	Conv.	16.1512	16.9218	4.55%
14	Foster Elementary	Jefferson Co.	Conv.	16.1130	17.1909	6.27%
15	Wilmore Elementary	Jessamine Co.	GHP	15.6612	16.1655	3.12%
16	Highland Elementary	Johnson Co.	Conv.	15.7573	17.1893	8.33%
17	Camp Ground Elementary	Laurel Co.	GHP	15.2218	15.9735	4.71%
18	Hazel Green Elementary	Laurel Co.	GHP	15.4280	15.7248	1.89%
19	Johnson Elementary	Laurel Co.	GHP	15.1975	15.7204	3.33%
20	Salyersville Grade School	Magoffin Co.	Conv.	16.1433	16.4101	1.63%
21	Eden Elementary	Martin Co.	GHP	15.7548	15.8186	0.40%
22	Eubank Elementary	Pulaski Co.	GHP	15.3262	15.5560	1.48%
23	Nancy Elementary	Pulaski Co.	GHP	15.4512	15.6485	1.26%
24	Pulaski Elementary	Pulaski Co.	GHP	15.9055	15.9084	0.02%
25	Shopville Elementary	Pulaski Co.	GHP	15.5747	15.7456	1.09%
26	Woodstock Elementary	Pulaski Co.	GHP	14.8421	15.1447	2.00%
27	Painted Stone Elementary	Shelby Co.	GHP	16.0303	16.8981	5.14%
28	Richardsville Elementary	Warren Co.	GHP	15.5776	15.9563	2.37%
29	Richpond Elementary	Warren Co.	GHP	15.8520	15.8518	0.00%
30	Rockfield Elementary	Warren Co.	Conv.	15.8963	16.8490	5.65%
31	No. Washington Elementary	Washington Co.	Conv.	15.8209	16.2516	2.65%



Maintenance

Since the intent of the study was to examine installed geothermal heat pump system performance, questions about scheduled and unscheduled maintenance were asked. Brief descriptions were solicited and are listed on the following two pages.

From Table 10 on maintenance (see next page) it does not appear as though either the GHP systems or the other systems require more maintenance than the other. From Table 11 on repairs (see page 22), it also seems that both geothermal and non-geothermal have a variety of maintenance issues. No firm conclusions can be drawn from the information given, but it appears as though there have been no more or less maintenance or repair issues with the GHP systems.

Table 10: Reported Maintenance

School	HVAC System	Scheduled Maintenance
Allen Co. Primary	GHP	Change filters at 3 months, inspect units, belts, bearings and record observations
Burning Springs Elementary	GHP	Filters monthly, coils yearly
Camp Ground Elementary	GHP	Change filters monthly, annual check of water level
Cannonsburg Elementary	GHP	Routine required filter changes
Crofton Elementary	GHP	Filter change every 3 months
East View Elementary	GHP	Filters every 3 months, pumps serviced 2x/yr, motors oiled, water treatment annually
Eden Elementary	GHP	Change air filters, lube pumps and motors, check temperature on loop system
Eubank Elementary	GHP	Filter changes monthly, inspect belts and grease every 9-12 months
Hazel Green Elementary	GHP	Change filters monthly, annual check of water level
Heritage Elementary	GHP	Routine inspection, filter changes, pump rotations
Johnson Elementary	GHP	Change filters monthly, annual check of water level
Nancy Elementary	GHP	Filter changes monthly, inspect belts and grease every 9-12 months
Painted Stone Elementary	GHP	Filters, every 3 months (classrooms)
Park City Elementary	GHP	Regular scheduled filter changes and maintenance
Pulaski Elementary	GHP	Filter changes done monthly, inspect belts and grease every 6 months
Red Cross Elementary	GHP	Regular scheduled filter changes, regular scheduled maintenance
Shopville Elementary	GHP	Filter changes monthly, inspect belts and grease every 9-12 months
Sinking Fork Elementary	GHP	Contracted filter change quarterly, water treatment in closed loop
Wilmore Elementary	GHP	Normal filter changes, grease, oil and belt changes, water treatment
Woodstock Elementary	GHP	Filter changes monthly, inspect belts and grease every 9-12 months
Chancey Elementary	Conv.	Filters replaced 4x/yr, belts inspected and changed
Erpenbeck Elementary	Conv.	Routine P.M. is performed on all HVAC equipment
Foster Elementary	Conv.	Filters, lube & belt changing. Water treat 2x/year. Boiler, chiller checkout list at least on start-ups
Greensburg Elementary	Conv.	Change filters, wash chilling towers, clean screens, grease, check belts, chemicals
No. Washington Elementary	Conv.	Quarterly PMC+ filter change, done by outside company
North Pointe Elementary	Conv.	Routine P.M. is performed on all HVAC equipment
Salyersville Grade School	Conv.	Monthly filter changes, grease/fill motors quarterly

Table 11: Reported Unscheduled Maintenance

School	HVAC System	Repairs
Allen Co. Primary	GHP	Several compressors replaced, expansion valves and relays replaced on a few
Burning Springs Elementary	GHP	Thermostat failures, transformer failures, a leak
Camp Ground Elementary	GHP	Freezer had to be taken off GHP due to soil conditions
Crofton Elementary	GHP	None
Eden Elementary	GHP	Compressors and fans burned out
Eubank Elementary	GHP	Change heat pump water every 9-12 months
Heritage Elementary	GHP	Repaired leak in loop inside building
Nancy Elementary	GHP	Change heat pump water every 9-12 months
Painted Stone Elementary	GHP	All fan motors replaced on classroom heat pumps, several heat pump compressors
Park City Elementary	GHP	Stopped-up strainers, blown fuses, loss of refrigerant
Pulaski Elementary	GHP	Change heat pump water loops every 9 to 12 months
Red Cross Elementary	GHP	Stopped-up strainers, blown fuses, loss of refrigerant
Richardsville Elementary	GHP	None
Richpond Elementary	GHP	None
Shopville Elementary	GHP	Change heat pump water every 9-12 months
Sinking Fork Elementary	GHP	Constant repair of breaks in ground loops at or near manifold, have to dig up back yard
Wilmore Elementary	GHP	None
Woodstock Elementary	GHP	Change heat pump water every 9-12 months
Chancey Elementary	Conv.	Some cooling fans on VAV drives have been replaced, 2 DDC controllers replaced
Erpenbeck Elementary	Conv.	Hot gas bypass added to compressor chillers to prevent them from cycling on too much
Foster Elementary	Conv.	4 Honeywell actuators on the hydronic loops have been replaced
Greensburg Elementary	Conv.	None
No. Washington Elementary	Conv.	Trouble with air handler, corrected by contractor
North Pointe Elementary	Conv.	Fan in gym (added frequency drive), refrigerant leaks, from vibration, repaired
Rockfield Elementary	Conv.	None
Salyersville Grade School	Conv.	Motor on cooling tower fan replaced twice

Missing Data, Out-liers and Discrepancies

Due to the nature of the study, where information has been gathered in a questionnaire with little independent verification and some information unavailable, there is certainly room to question the accuracy of the quantitative results. Addressing these issues should be part of Phase Two of the study. However, the general conclusions drawn from the study do seem conclusive.

The following are a list of the unresolved issues with the data at the time of the writing of this report:

- Park City Elementary is reported to have an extremely low EUI, about 6,600 Btu/ft²/yr. This number seems too low to be plausible but was not confirmed with the district after the survey was returned. For this reason, it was not used in calculating the average EUI of the GHP schools.
- Erpenbeck Elementary and Painted Stone were reported to have extremely high EUIs, and therefore were not used in calculating the average EUI.
- The following schools were not able to provide mechanical cost breakdowns: Cannonsburg Elementary (Boyd Co.); Richpond, Rockfield and Richardsville Elementaries (Warren Co.); Burning Springs Elementary (Clay Co); and Salyersville Elementary (Magoffin Co.).
- Six additional schools who agreed to participate have been unable to return the questionnaires at the writing of this report. They are Wayland Alexander Elementary (Ohio Co.), Brodhead Elementary (Rockcastle Co.), Hickman Elementary (Hickman Co.), Stamping Ground Elementary (Scott Co.), and Spencer County Primary.

Data from a group of schools that were not within the parameters of this survey was collected. This information has been retained for use if requested. These schools are Ballard County Elementary (Ballard Co.), Prichard Elementary (Carter Co.), South Christian Elementary (Christian Co.), Meadowlands Elementary (Daviess Co.), Whitesville Elementary (Daviess Co.), and Shelby Elementary (Jefferson Co.). Several of these were newer and several were older than the limits of the survey group, which was 1998 to 2002.

Environmental Impacts

A word should be said here about the impacts to the environment of the different types of systems. Although in tight budget times, the main concern of some is the cost benefit of installing GHP systems, others may be focused on the benefits to our habitat and reductions in greenhouse gasses. Michaela Martin of Oak Ridge National Laboratory points out that the source energy used in the mine-to-use process for electricity is about 3 times the source energy for the same amount of heating at the schools done with natural gas. The energy usage of these schools is broken down in the following table, and the Energy Use Index's were "modified" by multiplying the electric energy usage by 3. The results are shown only to point out that even with this factor accounted for the environmental case for using the GHP systems is strong, although the GHP schools with high EUIs drop to the bottom of the list. The resulting index is called the "Source Energy Use Index" (SEUI) so as not to be confused with the EUI shown in the report previously.

Table 12: Estimated Source Energy Use

HVAC System	School	Electric Usage (kWh/yr)	NG Usage (ccf/yr)	Source Energy Usage ¹ (MMBtu/yr)	SEUI (Btu/ft ² /yr)
GHP	Park City Elementary	105,155	0	1,076	19,937
GHP	Cannonsburg Elementary	288,207	0	2,950	68,400
GHP	Red Cross Elementary	520,800	0	5,331	82,077
GHP	East View Elementary	720,480	3,642	7,739	104,231
GHP	Crofton Elementary	731,800	0	7,491	121,800
GHP	Eden Elementary	720,984	0	7,380	126,111
GHP	Richpond Elementary	745,280	0	7,629	130,134
GHP	Pulaski Elementary	788,721	0	8,073	130,895
Conv.	Chancey Elementary	839,600	13706	9,965	131,115
Conv.	Foster Elementary	813,600	20872	10,415	133,528
GHP	Burning Springs Elementary	848,400	0	8,684	135,691
GHP	Allen Co. Primary	1,266,200	614.8	13,022	136,336
GHP	Shopville Elementary	670,201	0	6,860	143,201
Conv.	Rockfield Elementary	774,625	12806	9,210	146,539
GHP	Nancy Elementary	608,201	0	6,226	148,072
GHP	Heritage Elementary	936,000	0	9,581	150,331
GHP	Eubank Elementary	554,477	0	5,676	151,068
GHP	Hazel Green Elementary	656,400	0	6,719	154,867
GHP	Woodstock Elementary	367,487	0	3,762	155,869
GHP	Wilmore Elementary	1,020,000	0	10,441	157,121
GHP	Sinking Fork Elementary	914,860	0	9,365	157,747
Conv.	North Pointe Elementary	836,100	38816	12,440	164,115
Conv.	Salysersville Grade School	1,302,650	0	13,334	166,657
Conv.	Greensburg Elementary	1,144,800	0	11,718	167,882
Conv.	Highland Elementary	749,040	21490	9,816	168,637
GHP	Richardsville Elementary	827,400	0	8,469	186,935
Conv.	No. Washington Elementary	1,111,606	0	11,378	189,246
GHP	Johnson Elementary	653,520	0	6,689	196,748
Conv.	Erpenbeck Elementary	1,319,095	33814	16,884	214,260
GHP	Camp Ground Elementary	841,800	0	8,617	253,431
GHP	Painted Stone Elementary	2,121,960	0	21,720	285,795

1. Source Energy Use = kWh/yr x 0.003412 MMBtu/kWh x 3 + ccf/yr x 0.1 MMBtu/ccf = MMBtu/yr

Conclusions

The average Energy Use Index (EUI) of the GHP schools for the period from July 2003 to June 2004 was 48,369 Btu/ft²/yr. The average EUI for the schools with other systems was 65,596 Btu/ft²/yr for the same time period. Both sets of schools are from across the state and across climatic zones. The conclusion of this study with regard to energy use in the schools surveyed is that the GHP systems were performing significantly (about 26% by the numbers reported) better than the other systems on average. There was a high statistical standard deviation in both the GHP and the other schools with regard to the EUI. This may be the subject of future study. In other words, we would like to know why there is such a high variation in the performance of the systems. This information is presented in Tables 6 and 7 (see pages 12 and 13).

The average cost of the heating and cooling system per square foot of conditioned space (noted as mechanical cost/ft²) was reported to be slightly lower for the non-GHP systems than for the GHP systems, averaging about 4% higher. Results also show that, although energy used per student of the GHP schools was less, the energy cost per student was reported to be similar for the GHP schools. This is caused by the lower cost of the natural gas used for heating in the non-GHP schools.

Information was also solicited on a range of other issues affecting energy usage in individual buildings, such as number of occupants, number of computers, temperature settings and times of occupancy. This information was used to try to establish a comparison between the loads on the systems. The answers given were translated into a series of scores, shown in Table 8 (see page 16). The non-GHP schools do not appear to be significantly more loaded than the GHP schools in the study.

The variables for these schools are run through the algorithm of Portfolio Manager, an Energy Star® program, and the resulting number for predicted usage is compared to the results with the numbers for actual usage. The GHP schools appear to correlate to the data for typical school buildings nationally better than the non-GHP schools in Table 9 (see page 18).

Maintenance issues were collected in a short answer format. It does not appear that there has been more or less maintenance or repair required with the GHP systems than with the other systems. The results are shown in Tables 10 and 11 (see pages 21 and 22).

This study indicates that a Phase Two study should answer the question of why there is such extreme variation in performance of similar schools. This could be done by a study of the highest and lowest EUI schools in the study to identify the dominant causes. The committee guiding Phase One will address the scope of further investigations.

Appendix A – Study Scope of Work

Advising Committee:

Greg Guess
Kentucky Office of Energy Policy

Steve Roosa
Kentucky Energy Services Coalition

John Noel
Kentucky Department of Education

Michaela Martin
Oak Ridge National Laboratory

Billy Abner
East Kentucky Power Cooperative

Chuck Effinger
Energy Manager – Fayette County Public Schools

Additional advising received from:

Sri Iyer
Kentucky Pollution Prevention Center

James Bush
Kentucky Office of Energy Policy

Phase One: KPPC shall:

- Develop a survey instrument/questionnaire to collect energy consumption, building characteristics, HVAC system and building use data on schools using both geothermal and conventional HVAC system.
- Identify and collect relevant information from:
 - At least 18 elementary schools that have had geothermal systems installed long enough to have at least two state fiscal years (from July-June) energy consumption data.
 - From 12 – 18 elementary schools of similar size, age and construction that have conventional HVAC systems. There should be no more than two different types of systems in this sample.
- Conduct telephone surveys or site visits, if necessary, to get full and complete information on the schools selected.
- Analyze the data to compare system performance. This includes:
 - Developing indexes for energy consumption, e.g., kBtu/ft², \$/student and other such indices as may be appropriate.
 - Developing a method to account for or normalize for variations, such as
 - Climate (degree days);

- Energy-consuming applications (presence or absence of kitchen; swimming pool, athletic field lighting, gymnasium, etc., and
 - Building occupancy and use patterns.
- Prepare a report summarizing its findings during Phase One of the project. The report shall include:
 - An analysis comparing the performance of geothermal systems in the facilities surveyed.
 - An analysis comparing the performance of geothermal systems surveyed to the conventional system surveyed.
 - Where outliers are found in the data, additional information will be sought to determine the validity of the data received.
 - The report shall, if feasible, quantify the additional capital costs associated with the geothermal systems versus the expected benefits from lower operating costs.

In addition, if available funds have not been exhausted, KPPC shall begin work on Phase Two of the project as outlined below. If sufficient funds are not available to initiate, or having been initiated, to complete Phase Two, the Cabinet and KPPC will explore alternative funding for Phase Two.

Phase Two: KPPC shall:

- Identify three or more buildings with geothermal systems surveyed in Phase One of this project to examine in more detail for case studies. KPPC shall provide an assessment of:
 - System design – Was the system properly designed for the facility? (Look at such factors as borehole spacing and depth, number of boreholes, subsurface geology, controls, pumps, etc.)
 - System installation – Was the system properly installed and commissioned?
 - System operation and maintenance – Were system operators trained in correct operation and maintenance procedures? Are the procedures being followed? Are system controls being used correctly? Is the system being operated to match building occupancy patterns? Are thermostat set points reasonable?
 - Other factors – Are there any other factors that would lead to excessive energy consumption in the identified facilities?
- Prepare a report that:
 - Identifies problems and the source of those problems.
 - Recommends corrective actions to bring geothermal systems up to acceptable performance standards.
 - Recommends methods or practices to get these actions adopted at the local school district level.
 - Recommends action(s) to avoid similar problems in future design, installation or operation and maintenance of geothermal systems.

Appendix B – Survey Questions

General Information:

1. Name of school_____
2. School district_____
3. Contact person for additional information_____
4. Telephone no._____
5. E-mail address_____
6. Age of school_____
7. Name of architectural firm(s) involved with construction of this school _____

8. Name of engineering firm(s) involved with construction of this school _____

9. Occupancy of the school, *dates, times, numbers of students and staff*
Total staff _____
Total students (*enrollment*)_____
Total students (*Average Daily Attendance*) _____
Dates of occupancy_____
Normal times of occupancy_____

Building Equipment:

10. Type of heating and cooling system(s), *gas two pipe VAV, four pipe, geothermal heat pump (GHP), chillers or rooftop AC ... number and size of air handlers*

11. Cost of building heating and cooling systems_____
12. Dates of operation for heating and cooling systems, *if GHP, date of switch-over*
Typical start and end dates for heating_____
Typical start and end dates for cooling_____
13. Ages of heating and cooling systems_____
14. Brief description of scheduled operations and maintenance procedures for heating and cooling systems

15. Brief description of any unplanned maintenance to HVAC equipment since the school opened

16. Special energy saving features, *economizers, automated building controls, energy recovery equipment, etc.*

Energy Information:

17. Annual energy consumption for school, *July 2003 to June 2004*

Electric: *There are two main parts of an electricity bill: the amount of electricity consumed per kilowatt-hour (kWh) and a demand charge, per kilowatt (kW), based on the highest electricity use each month, averaged over a 15-minute period. If there are outside lights or buildings metered separately, they need not be included.*

Total annual kWh _____

Total annual kW _____

Natural Gas: *Your gas may be billed by hundreds of cubic feet (ccf), thousands of cubic feet (Mcf), thousands of British thermal units (MBtu), millions of Btu (MMBtu) or dekatherms (dt). Please indicate which unit you are reporting.*

Total annual natural gas units _____ (ccf, Mcf, MBtu, MMBtu, dt)

Total annual propane gas units _____ (gal) (*not including stored*)

Total annual #2 fuel oil units _____ (gal) (*not including stored*)

18. Annual energy costs for school, *July 2003 to June 2004. Please break down by fuel type as above.* _____

19. Additional energy users

a. Pools _____ (yes or no)

b. Kitchen _____ (yes or no)

c. No. of computers _____

d. No. of vending machines _____

e. Other.... _____

f. _____

20. Outdoor lighting if included in annual energy consumption listed above, *ball fields, parking lots, sign lighting, etc.* (not necessary in metered separately and not counted for totals) _____

Building Envelope:

21. Square footage of heated space in the school _____ (ft²) *Indicate if square footage changed during the two years for which data is being collected.*

22. Square footage of cooled space in the school _____ (ft²) *Indicate if square footage changed during the two years for which data is being collected.*

23. Wall construction type, *block, brick, wood frame, etc.*

24. Primary type of window, *double pane, thermal pane, etc.*

25. Roof construction type, *flat, sloped, type and quantity of insulation, etc.*

Appendix C – Questionnaire Responses by School

Number Geothermal ☒
School
County
School Street Address

City State Zip
Status of Survey

Age of School
Contact
E-mail
Phone
School Phone Number

Architect
Engineer
No. of Staff No. of Students
ADA Dates of School Year
Hours in School Day
Other Occupancy

Building Envelope:

Heated Space (ft2)
Cooled Space (ft2)
Wall Construction
Windows
Roof

Additional Comments:

Actual temperature setpoints are individually set. One unit was completely replaced. Gas usage was given as 404400 ccf, figure not used because not plausible for GHP school. Loads set to 3 although there are no outside lights.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)
Electric Demand (kW/yr)
Annual Electric Cost
Natural Gas Usage (ccf/yr)
Annual Natural Gas Cost
Propane Usage (gal/yr)
Annual Propane Cost
Pool Kitchen
Computers Vending Machines
Outdoor Lighting

Mechanical Systems:

Cost Type
Cooling Days
Heating Days
Age
Scheduled Maintenance Description

Repairs or Failures Reported

Energy Saving Features

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	<input type="text" value="2"/>	Geothermal	<input checked="" type="checkbox"/>	Age of School	<input type="text" value="2001 (4 years)"/>	Architect	<input type="text" value="RBS Design Group. PSC"/>
School	<input type="text" value="Park City Elementary"/>			Contact	<input type="text" value="Steve Russell"/>	Engineer	<input type="text" value="Waldron, Batey, and Wade Inc."/>
County	<input type="text" value="Barren Co."/>			E-mail	<input type="text" value="srussell@barren.k12.ky.us"/>		
School Street Address	<input type="text" value="45 Indian Mill Rd."/>			Phone	<input type="text" value="270-651-3787"/>	No. of Staff	<input type="text" value="55"/> No. of Students <input type="text" value="332"/>
	<input type="text"/>			School Phone Number	<input type="text" value="270-749-5074"/>	ADA	<input type="text" value="309"/> Dates of School Year <input type="text" value="Aug-may"/>
City	<input type="text" value="Park City"/>	State	<input type="text" value="KY"/>	Zip	<input type="text" value="42160"/>	Hours in School Day	<input type="text" value="7"/>
Status of Survey	<input type="text" value="in before 4/5/05"/>						
Other Occupancy <input type="text"/>							

Building Envelope:

Heated Space (ft2)	<input type="text" value="53,989"/>
Cooled Space (ft2)	<input type="text" value="51,000"/>
Wall Construction	<input type="text" value="block and brick"/>
Windows	<input type="text" value="thermal pane"/>
Roof	<input type="text" value="sloped, raised seam, 3in insul."/>

Additional Comments:

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	<input type="text" value="105,155"/>
Electric Demand (kW/yr)	<input type="text"/>
Annual Electric Cost	<input type="text" value="\$68,798.29"/>
Natural Gas Usage (ccf/yr)	<input type="text" value="0"/>
Annual Natural Gas Cost	<input type="text" value="\$0.00"/>
Propane Usage (gal/yr)	<input type="text" value="0"/>
Annual Propane Cost	<input type="text" value="\$0.00"/>
Pool	<input type="text" value="no"/>
Kitchen	<input type="text" value="yes"/>
Computers	<input type="text" value="80"/>
Vending Machines	<input type="text" value="4"/>
Outdoor Lighting	<input type="text"/>

Mechanical Systems:

Cost	<input type="text" value="\$611,859"/>	Type	<input type="text" value="GHP"/>
Cooling Days	<input type="text" value="182"/>		
Heating Days	<input type="text" value="183"/>		
Age	<input type="text" value="4 years"/>		
Scheduled Maintenance Description			
<input type="text" value="Regular scheduled filter changes and maintenance"/>			
Repairs or Failures Reported			
<input type="text" value="Stopped up strainers, blown fuses, loss of refrigerant"/>			
Energy Saving Features			
<input type="text" value="Automated Building Controls"/>			

Scoring:

Scheduling	<input type="text" value="1"/>	Building Characteristics	<input type="text" value="2"/>	Loads	<input type="text" value="1"/>	Sc HDD	<input type="text" value="1"/>	SP Heat:	<input type="text" value="68-50"/>	HDD Avg:	<input type="text" value="3862"/>
								SP Cool:	<input type="text" value="72-95"/>	CDD Avg:	<input type="text" value="1"/>

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	3	Geothermal	<input checked="" type="checkbox"/>	Age of School	1999 (6 years)	Architect	RBS Design Group PSC
School	Red Cross Elementary			Contact	Steve Russell	Engineer	Waldron, Batey, and Wade Inc.
County	Barren Co.			E-mail	srussell@barren.k12.ky.us	No. of Staff	80
School Street Address	215 Parkview Drive			Phone	270-651-3787	No. of Students	695
City	Glasgow	State	KY	School Phone Number	270-659-0052	ADA	681
Zip	42141	Dates of School Year	Aug-May				
Status of Survey	in before 4/5/05						
Hours in School Day	7						
Other Occupancy							

Building Envelope:

Heated Space (ft2)	64,950
Cooled Space (ft2)	61,950
Wall Construction	block and brick
Windows	thermal pane
Roof	sloped, raised seam (3in)

Additional Comments:

Loads set to 5 although ancillary equipment is less than 150

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	520,800
Electric Demand (kW/yr)	2,330.0
Annual Electric Cost	\$55,952.84
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	115
Vending Machines	8
Outdoor Lighting	57

Mechanical Systems:

Cost	\$598,268	Type	GHP
Cooling Days	182	Heating Days	183
Age	6	Scheduled Maintenance Description	Regular scheduled filter changes, regular scheduled maintenance
Repairs or Failures Reported	Stopped up strainers, blown fuses, loss of refrigerant		
Energy Saving Features	Automated building controls		

Scoring:

Scheduling

1

Building Characteristics

2

Loads

5

Sc HDD

1

SP Heat: 68-50

HDD Avg: 3862

SP Cool: 72-95

CDD Avg: 1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number Geothermal ☐
School
County
School Street Address

City State Zip
Status of Survey

Age of School
Contact
E-mail
Phone
School Phone Number

Architect
Engineer
No. of Staff No. of Students
ADA Dates of School Year
Hours in School Day
Other Occupancy

Building Envelope:

Heated Space (ft2)
Cooled Space (ft2)
Wall Construction
Windows
Roof

Additional Comments:

(other system information) 8 4-pipe air handlers with energy heat recovery. VAV boxes with reheat. Sytecon variable flow pump package for hot and chilled water, HDD and CDD from Kenton Co. Scheduling set to 5 although not operating throughout the year.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)
Electric Demand (kW/yr)
Annual Electric Cost
Natural Gas Usage (ccf/yr)
Annual Natural Gas Cost
Propane Usage (gal/yr)
Annual Propane Cost
Pool Kitchen
Computers Vending Machines
Outdoor Lighting

Mechanical Systems:

Cost Type
Cooling Days 2 gas hot water
Heating Days boilers. 2 electric
Age water chillers

Scheduled Maintenance Description

Routine P.M. is performed on all HVAC equipment

Repairs or Failures Reported

Hot gas bypass added to compressor chillers to prevent them from cycling on too much.

Energy Saving Features

DDC controls w/ setbacks, economizers, w/ enthalpy control, energy recovery. More!

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	5	Geothermal	<input type="checkbox"/>	Age of School	2000 (5 years)	Architect	Hayes & Associates
School	North Pointe Elementary			Contact	Cindy Densler	Engineer	KLH
County	Boone Co.			E-mail	cdensler@boone.k12.ky.us		
School Street Address	875 North Bend Rd.			Phone	(859) 282-2369	No. of Staff	152
				School Phone Number	859-334-7000	No. of Students	745
City	Hebron	State	KY			ADA	611
Zip	41048					Dates of School Year	
Status of Survey	in 5/1						
Hours in School Day		9.5					
Other Occupancy							

Building Envelope:

Heated Space (ft2)	75,800
Cooled Space (ft2)	75,800
Wall Construction	Block & brick
Windows	Thermal Pane
Roof	Flat

Additional Comments:

(other system information) 8 4-pipe air handlers. Classroom 3 VAV boxes with reheat. Loads set to 3 although no outdoor lighting

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	836,100
Electric Demand (kW/yr)	
Annual Electric Cost	\$57,247.61
Natural Gas Usage (ccf/yr)	38816
Annual Natural Gas Cost	\$35,776.40
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	0
Vending Machines	0
Outdoor Lighting	

Mechanical Systems:

Cost	\$1,217,000	Type	
Cooling Days	Mar-Nov	2 gas h.w. boilers, 3 air cooled elect. chillers	
Heating Days	Nov-Mar		
Age	2000 (5 years)		
Scheduled Maintenance Description			
Routine P.M. is performed on all HVAC equipment			
Repairs or Failures Reported			
Fan in gym (added frequency drive). Refrigerant leaks, from vibration, repaired.			
Energy Saving Features			
DDC cntrls, economizers, VFD, free cooling, enthalpy control, start stop optimization used.			

Scoring:

Scheduling

3

Building Characteristics

1

Loads

3

Sc HDD

5

SP Heat:

72

HDD Avg:

5148

SP Cool:

72

CDD Avg:

0

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	6	Geothermal	<input checked="" type="checkbox"/>	Age of School	1962,1985,2000	Architect	Clotfelder/Samokar, PSC
School	Cannonsburg Elementary			Contact	Pete Miller	Engineer	Adams Fazier,Anderson, Inc.
County	Boyd Co			E-mail	pmiller@boyd.k12.ky.us	No. of Staff	60
School Street Address	12219 Midland Trail Rd			Phone	606-928-4141 or 7124	No. of Students	301
City	Ashland	State		School Phone Number	606-928-7131	ADA	282
Zip	41102	Dates of School Year	Aug 2-May 24				
Status of Survey	in 5/ 31						
Hours in School Day	8						
Other Occupancy							

Building Envelope:

Heated Space (ft2)	43,130
Cooled Space (ft2)	46,130
Wall Construction	block
Windows	single pane and double pane
Roof	flat and sloped

Additional Comments:

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	288,207
Electric Demand (kW/yr)	
Annual Electric Cost	\$41,937.05
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	
Kitchen	yes
Computers	183
Vending Machines	4
Outdoor Lighting	street lights

Mechanical Systems:

Cost		Type	
Cooling Days	90	Heating Days	195
Age			
Scheduled Maintenance Description	Routine required filter changes		
Repairs or Failures Reported			
Energy Saving Features			

Scoring:

Scheduling

3

Building Characteristics

5

Loads

3

Sc HDD

5

SP Heat:

HDD Avg:

5217

SP Cool:

CDD Avg:

1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	<input type="text" value="7"/>	Geothermal	<input type="checkbox"/>	Age of School	<input type="text" value="2000 (5 years)"/>	Architect	<input type="text" value="Clotfelder/Samokar"/>
School	<input type="text" value="Heritage Elementary"/>			Contact	<input type="text" value="Jim Scott"/>	Engineer	<input type="text" value="GRW"/>
County	<input type="text" value="Carter Co."/>			E-mail	<input type="text" value="jjiscott@carter.k12.ky.us"/>		
School Street Address	<input type="text" value="4863 S. State Hwy 1"/>			Phone	<input type="text" value="606-474-2002"/>	No. of Staff	<input type="text" value="65"/> No. of Students <input type="text" value="437"/>
	<input type="text"/>			School Phone Number	<input type="text" value="606-286-5982"/>	ADA	<input type="text" value="407"/> Dates of School Year <input type="text" value="Aug-May"/>
City	<input type="text" value="Hitchens"/>	State	<input type="text" value="KY"/>	Zip	<input type="text" value="41146"/>	Hours in School Day	<input type="text" value="8"/>
Status of Survey	<input type="text" value="in before 4/5/05"/>						
Other Occupancy <input type="text"/>							

Building Envelope:

Heated Space (ft2)	<input type="text" value="63,732"/>
Cooled Space (ft2)	<input type="text" value="63,732"/>
Wall Construction	<input type="text" value="Block, brick"/>
Windows	<input type="text" value="thermal pane"/>
Roof	<input type="text" value="metal sloped"/>

Additional Comments:

Loads set to 3 although students/100 sq-ft is less than 0.75

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	<input type="text" value="936,000"/>
Electric Demand (kW/yr)	<input type="text" value="3,529.0"/>
Annual Electric Cost	<input type="text" value="\$48,650.08"/>
Natural Gas Usage (ccf/yr)	<input type="text" value="0"/>
Annual Natural Gas Cost	<input type="text" value="\$0.00"/>
Propane Usage (gal/yr)	<input type="text"/>
Annual Propane Cost	<input type="text"/>
Pool	<input type="text" value="No"/>
Kitchen	<input type="text" value="Yes"/>
Computers	<input type="text" value="138"/>
Vending Machines	<input type="text" value="3"/>
Outdoor Lighting	<input type="text" value="parking lot lighting"/>

Mechanical Systems:

Cost	<input type="text" value="\$1,089,817"/>	Type	<input type="text" value="GHP"/>
Cooling Days	<input type="text" value="182"/>		
Heating Days	<input type="text" value="183"/>		
Age	<input type="text" value="5 years"/>		
Scheduled Maintenance Description			
<input type="text" value="routine inspecton, filter changes, pump rotations"/>			
Repairs or Failures Reported			
<input type="text" value="Repaired leak in loop inside building"/>			
Energy Saving Features			
<input type="text"/>			

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number Geothermal ☒
School
County
School Street Address

City State Zip
Status of Survey

Age of School
Contact
E-mail
Phone
School Phone Number

Architect
Engineer
No. of Staff No. of Students
ADA Dates of School Year
Hours in School Day
Other Occupancy

Building Envelope:

Heated Space (ft2)
Cooled Space (ft2)
Wall Construction
Windows
Roof

Additional Comments:

Loads set to 1 although ancillary equipment is more than 150 and has outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)
Electric Demand (kW/yr)
Annual Electric Cost
Natural Gas Usage (ccf/yr)
Annual Natural Gas Cost
Propane Usage (gal/yr)
Annual Propane Cost
Pool Kitchen
Computers Vending Machines
Outdoor Lighting

Mechanical Systems:

Cost Type
Cooling Days
Heating Days
Age
Scheduled Maintenance Description

Repairs or Failures Reported

Energy Saving Features

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	9	Geothermal	<input checked="" type="checkbox"/>	Age of School	1998 (7 years)	Architect	Gary Violette (931-552-6884 or 94)
School	Sinking Fork Elementary			Contact	Ann Giles	Engineer	Waldron, Batey and Wade (270-886-2536)
County	Christian Co.			E-mail	agiles@christian.k12.ky.us	No. of Staff	64
School Street Address	5005 Princeton Rd.			Phone	(270) 887-1180	No. of Students	331
City	Hopkinsville	State	KY	School Phone Number	270-887-1180	ADA	302
Zip	42240	Dates of School Year	Aug-May				
Status of Survey	in 4/05						
Hours in School Day	7						
Other Occupancy							

Building Envelope:

Heated Space (ft2)	59,364
Cooled Space (ft2)	59,364
Wall Construction	block, brick
Windows	thermal pane
Roof	sloped

Additional Comments:

Waldron Batey and Wade gave the square footage as 56,367 ft. sq. Loads set to 1 although ancillary equipment is more than 150 and has outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	914,860
Electric Demand (kW/yr)	2,867.0
Annual Electric Cost	\$81,519.75
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	150
Vending Machines	3
Outdoor Lighting	parking lots

Mechanical Systems:

Cost	\$630,540	Type	
Cooling Days	187	Heating Days	178
Age	7 years	Scheduled Maintenance Description	Contracted filter change quarterly, water treatment in closed loop
Repairs or Failures Reported	Constant repair of breaks in ground loops at or near manifold, have to dig up back yard		
Energy Saving Features	Automated building controls		

Scoring:

Scheduling	Building Characteristics	Loads	Sc HDD	SP Heat:	68-70	HDD Avg:	4298
1	2	1	1	SP Cool:	70	CDD Avg:	1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	10	Geothermal	<input checked="" type="checkbox"/>	Age of School	1958, renovation 2002	Architect	Clotfelder/Samokar
School	Burning Springs Elementary			Contact	John Brown/Ed Rawlings	Engineer	Adams Frazier Anderson
County	Clay Co.			E-mail	jbrown@clay.k12.ky.us		
School Street Address	9847 N Hwy 421			Phone	606-598-2168	No. of Staff	46
				School Phone Number	606-598-3138	No. of Students	407
City	Manchester	State	KY			ADA	377
Zip	40962					Dates of School Year	Aug-May
Status of Survey	in 4/11/05						
						Hours in School Day	8.75
						Other Occupancy	custodian 10:PM, many event

Building Envelope:

Heated Space (ft2)	64,000
Cooled Space (ft2)	64,000
Wall Construction	Block
Windows	thermal pane, tinted
Roof	flat. 1/2 building rubber, 1/2 modifie

Additional Comments:

-have basketball games, PTA mtgs, governors cups, academic programs. These buildings have become community bldgs. Even elementary have football training. -"Before renovation bldg was 1/2 the current size & cost more to run," Ed Rawlings.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	848,400
Electric Demand (kW/yr)	2,807.0
Annual Electric Cost	\$51,630.60
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	
Annual Propane Cost	
Pool	no
Kitchen	yes
Computers	127
Vending Machines	10
Outdoor Lighting	metered separately

Mechanical Systems:

Cost		Type	
Cooling Days	182	GHP	
Heating Days	183		
Age	2 to 3 years		
Scheduled Maintenance Description			
Filters monthly, coils yearly			
Repairs or Failures Reported			
Thermostat failures, transformer failures, a leak			
Energy Saving Features			
Energy recovery wheel, automated controls			

Scoring:

Scheduling	Building Characteristics	Loads	Sc HDD	SP Heat:	HDD Avg:
3	4	1	5		4766
				SP Cool:	CDD Avg:
					1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number **11** **Geothermal** ☒
School **East View Elementary**
County **Daviess Co.**
School Street Address
6104 Ky Hwy 405
City **Owensboro** **State** **KY** **Zip** **42303**
Status of Survey **in before 4/5/05**

Age of School **1998 (8 years)**
Contact **Ed Higdon**
E-mail **ehigdon@dcps.org**
Phone **270-852-7000**
School Phone Number **270-852-7350**

Architect **Colligan and Nunley**
Engineer **Waldron, Batey and Wade**
No. of Staff **76** No. of Students **450**
ADA **450** Dates of School Year **Aug 11-May 1**
Hours in School Day **7**
Other Occupancy

Building Envelope:

Heated Space (ft2) **74,249**
Cooled Space (ft2) **74,249**
Wall Construction **Block and Brick**
Windows **Thermal Pane**
Roof **metal sloped, 6" insulation on roof**

Additional Comments:

Loads set to 1 although ancillary equipment is more than 100 and has outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr) **720,480**
Electric Demand (kW/yr)
Annual Electric Cost **\$46,434.77**
Natural Gas Usage (ccf/yr) **3642**
Annual Natural Gas Cost **\$3,483.11**
Propane Usage (gal/yr)
Annual Propane Cost
Pool **no** Kitchen **yes**
Computers **122** Vending Machines **3**
Outdoor Lighting **marque sign & parking lot lights**

Mechanical Systems:

Cost Type
Cooling Days **215** **GHP**
Heating Days **150**
Age **8 years**
Scheduled Maintenance Description
Filters every 3 months, pumps serviced 2x/yr, motors oiled, water treatment annually
Repairs or Failures Reported

Energy Saving Features
Energy management system

Scoring:

Scheduling

1

Building Characteristics

2

Loads

1

Sc HDD

1

SP Heat: **72-55**

HDD Avg: **4159**

SP Cool: **?**

CDD Avg: **1**

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	12	Geothermal	<input type="checkbox"/>	Age of School	2002 (3 years)	Architect	Gary Scott and Associates (Craig Aosse)
School	Greensburg Elementary			Contact	Jim Frank	Engineer	CMTA Consulting Engineers
County	Green Co.			E-mail	jfrank@green.k12.ky.us		
School Street Address				Phone	270-932-5231		
P.O. Box	150			School Phone Number	270-932-6172	No. of Staff	67
100 Kidz Korner						No. of Students	450
City		State				ADA	427
Greensburg		KY				Dates of School Year	
Zip						Hours in School Day	8
						Other Occupancy	
Status of Survey	in 5/24						

Building Envelope:

Heated Space (ft2)	69,800
Cooled Space (ft2)	69,800
Wall Construction	block and brick cavity w
Windows	Thermal Pane
Roof	80% metal sloped, 20% built up mo

Additional Comments:

Loads set to 1 although has outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	1,144,800
Electric Demand (kW/yr)	4,986.0
Annual Electric Cost	\$51,196.61
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	0
Vending Machines	2
Outdoor Lighting	Parking, street lights, apr: 25

Mechanical Systems:

Cost	\$763,424	Type	
Cooling Days	183	Heating with four pipe - Cooling with chillers	
Heating Days	182		
Age	2.5 years		
Scheduled Maintenance Description			
Change filters, wash chilling towers, clean screens, grease, check belts, chemicals			
Repairs or Failures Reported			
None			
Energy Saving Features			
Energy Recovery Wheel, have evening and weekend setbacks but only 4 degrees.			

Scoring:

Scheduling

1

Building Characteristics

1

Loads

1

Sc HDD

3

SP Heat:

72

HDD Avg:

4451

SP Cool:

70

CDD Avg:

1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number **13** **Geothermal** ☐
School **Chancey Elementary**
County **Jefferson Co.**
School Street Address
4301 Murphy Lane
City **Louisville** **State** **KY** **Zip** **40241**
Status of Survey **in before 4/5/05**

Age of School **2002 (three years)**
Contact **Kevin Stoltz**
E-mail **kstoltz1@jefferson.k12.ky.us**
Phone **502-485-7714**
School Phone Number

Architect **McCulloch Associates**
Engineer **LSE**
No. of Staff **72** No. of Students **759**
ADA **732** Dates of School Year **all year**
Hours in School Day **8.5**
Other Occupancy

Building Envelope:

Heated Space (ft2) **76,000**
Cooled Space (ft2) **64,600**
Wall Construction **Block & brick**
Windows **thermal pane, aluminum**
Roof **flat roof - minimum R-10.**

Additional Comments:

additional roof info: 1" perlite mechanically attached, 2 ply vapor retarder, 1 1/2 rigid insulation fiberglass overlay, 4 ply modified asphalt B.U.R. gravel surface

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr) **839,600**
Electric Demand (kW/yr) **3,588.0**
Annual Electric Cost **\$54,242.58**
Natural Gas Usage (ccf/yr) **13706**
Annual Natural Gas Cost **\$13,379.61**
Propane Usage (gal/yr)
Annual Propane Cost
Pool **no** Kitchen **yes**
Computers **143** Vending Machines **0**
Outdoor Lighting **not separated**

Mechanical Systems:

Cost **\$992,500** Type
Cooling Days **182** VAV with gas heat
Heating Days **183**
Age **4 years**
Scheduled Maintenance Description
Filters replaced 4x/yr, belts inspected and changed,
Repairs or Failures Reported
Some cooling fans on VAV drives have been replaced, 2 DDC controllers replaced
Energy Saving Features
Economizers, DDC system, boilers use resets

Scoring:

Scheduling

5

Building Characteristics

1

Loads

5

Sc HDD

3

SP Heat: **69-73**

HDD Avg: **4352**

SP Cool: **73-77**

CDD Avg: **1**

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number Geothermal ☐
School
County
School Street Address

City State Zip
Status of Survey

Age of School
Contact
E-mail
Phone
School Phone Number

Architect
Engineer
No. of Staff No. of Students
ADA Dates of School Year
Hours in School Day
Other Occupancy

Building Envelope:

Heated Space (ft2)
Cooled Space (ft2)
Wall Construction
Windows
Roof

Additional Comments:

Loads set to 3 although ancillary equipment more than 150

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)
Electric Demand (kW/yr)
Annual Electric Cost
Natural Gas Usage (ccf/yr)
Annual Natural Gas Cost
Propane Usage (gal/yr)
Annual Propane Cost
Pool Kitchen
Computers Vending Machines
Outdoor Lighting

Mechanical Systems:

Cost Type
Cooling Days two pipe fan coils, 6-AHU's, 3 boilers, 2 chillers
Heating Days
Age
Scheduled Maintenance Description
Filters, lubrication & belt changing. Water treatment 2x/year. Boiler, chiller checkout list
Repairs or Failures Reported
4 Honeywell actuators on the hydronic loops have been replaced
Energy Saving Features
Fan coils in rooms with outside air supplied by air handlers, DDC (Alerton)

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	15	Geothermal	<input checked="" type="checkbox"/>	Age of School	2000 (5 years)	Architect	Sherman Carter Barnhart
School	Wilmore Elementary			Contact	Shirley Smith	Engineer	CMTA
County	Jessamine Co.			E-mail		No. of Staff	50
School Street Address	150 Campground Ln			Phone	859-885-4179	No. of Students	570
				School Phone Number	859-858-3134	ADA	540
City	Wilmore	State	KY			Dates of School Year	?
		Zip	40390			Hours in School Day	7
Status of Survey	in 6/17/05						

Building Envelope:

Heated Space (ft2)	66,450
Cooled Space (ft2)	66,450
Wall Construction	Block
Windows	Thermal pane
Roof	Flat

Additional Comments:

HDD and CDD from Fayette Co.. District reports that there are many computers. Setpoints not collected, assumed to be middle option (cool to 72 and heat to 68 degrees).

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	1,020,000
Electric Demand (kW/yr)	4,248.0
Annual Electric Cost	\$52,318.81
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	
Vending Machines	6
Outdoor Lighting	Yes, included.

Mechanical Systems:

Cost	\$1,067,922	Type	
Cooling Days	182	Heating Days	183
Age	5 years		
Scheduled Maintenance Description	Normal filter changes, grease, oil and belt changes, water treatment		
Repairs or Failures Reported	None		
Energy Saving Features	None		

Scoring:

Scheduling

1

Building Characteristics

2

Loads

3

Sc HDD

3

SP Heat:

HDD Avg:

4713

SP Cool:

CDD Avg:

1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number <input type="text" value="16"/>	Geothermal <input type="checkbox"/>	Age of School <input type="text" value="7 yrs"/>	Architect <input type="text" value="Associated Designers"/>
School <input type="text" value="Highland Elementary"/>	Contact <input type="text" value="Scott Rowland"/>	Engineer <input type="text" value="AFA"/>	
County <input type="text" value="Johnson Co."/>	E-mail <input type="text" value="srowland@johnson.k12.ky.us"/>	No. of Staff <input type="text" value="70"/>	No. of Students <input type="text" value="461"/>
School Street Address <input type="text"/> <input type="text"/>	Phone <input type="text" value="606-789-2530"/>	ADA <input type="text" value="445"/>	Dates of School Year <input type="text" value="Aug to May"/>
City <input type="text" value="Paintsville"/>	State <input type="text"/> <input type="text"/>	Hours in School Day <input type="text" value="8"/>	Other Occupancy <input type="text"/>
Zip <input type="text"/>	School Phone Number <input type="text"/>		
Status of Survey <input type="text" value="in 6/20/05"/>			

Building Envelope:

Heated Space (ft2)

Cooled Space (ft2)

Wall Construction

Windows

Roof

Additional Comments:

Setpoints not collected, assumed to be middle option (cool to 72 and heat to 68 degrees). Scheduling set to 3 as the hours of school day is 8 hours. Building characteristics not available, assumed 3.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)

Electric Demand (kW/yr)

Annual Electric Cost

Natural Gas Usage (ccf/yr)

Annual Natural Gas Cost

Propane Usage (gal/yr)

Annual Propane Cost

Pool **Kitchen**

Computers **Vending Machines**

Outdoor Lighting

Mechanical Systems:

Cost **Type**

Cooling Days

Heating Days

Age

Scheduled Maintenance Description

Repairs or Failures Reported

Energy Saving Features

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number Geothermal ☒
School
County
School Street Address

City State Zip
Status of Survey

Age of School
Contact
E-mail
Phone
School Phone Number

Architect
Engineer
No. of Staff No. of Students
ADA Dates of School Year
Hours in School Day
Other Occupancy

Building Envelope:

Heated Space (ft2)
Cooled Space (ft2)
Wall Construction
Windows
Roof

Additional Comments:

At renovation added 17,000 ft2 and eliminated a gas boiler. Electric bill essentially stayed the same. Would not conceive of putting in a new school without geothermal.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)
Electric Demand (kW/yr)
Annual Electric Cost
Natural Gas Usage (ccf/yr)
Annual Natural Gas Cost
Propane Usage (gal/yr)
Annual Propane Cost
Pool Kitchen
Computers Vending Machines
Outdoor Lighting

Mechanical Systems:

Cost Type
Cooling Days
Heating Days
Age
Scheduled Maintenance Description

Repairs or Failures Reported

Energy Saving Features

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number Geothermal ☒
School
County
School Street Address

City State Zip
Status of Survey

Age of School
Contact
E-mail
Phone
School Phone Number

Architect
Engineer
No. of Staff No. of Students
ADA Dates of School Year
Hours in School Day
Other Occupancy

Building Envelope:

Heated Space (ft2)
Cooled Space (ft2)
Wall Construction
Windows
Roof

Additional Comments:

Loads set to 1 although has outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)
Electric Demand (kW/yr)
Annual Electric Cost
Natural Gas Usage (ccf/yr)
Annual Natural Gas Cost
Propane Usage (gal/yr)
Annual Propane Cost
Pool Kitchen
Computers Vending Machines
Outdoor Lighting

Mechanical Systems:

Cost Type
Cooling Days
Heating Days
Age
Scheduled Maintenance Description

Repairs or Failures Reported

Energy Saving Features

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	19	Geothermal	<input checked="" type="checkbox"/>	Age of School	1962, renovation in 2001	Architect	Sherman-Carter-Barnhart PSC
School	Johnson Elementary			Contact	Jim Kennedy	Engineer	KTA Consulting Engineers
County	Laurel Co.			E-mail	jkennedy-311@laurel.k12.ky.us		
School Street Address	1781 McWharter Rd			Phone	606-862-4600	No. of Staff	35
				School Phone Number	606-862-4664	No. of Students	272
City	London	State	KY			ADA	249
Zip	40741					Dates of School Year	Aug-May
Status of Survey	in (4/12/05)						
						Hours in School Day	9
						Other Occupancy	

Building Envelope:

Heated Space (ft2)	34,000
Cooled Space (ft2)	34,000
Wall Construction	block w/ brick veneer
Windows	thermal pane
Roof	flat-24,700 sqft, metal roof-9300 sqf

Additional Comments:

Loads set to 1 although has outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	653,520
Electric Demand (kW/yr)	2,629.0
Annual Electric Cost	\$39,175.49
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	
Annual Propane Cost	
Pool	no
Kitchen	yes
Computers	75
Vending Machines	4
Outdoor Lighting	parking lot

Mechanical Systems:

Cost	\$599,412	Type	
Cooling Days		Heating Days	
Age	4 years	Scheduled Maintenance Description	Change filters monthly, annual check of water level
Repairs or Failures Reported			
Energy Saving Features			
Energy recovery equipment			

Scoring:

Scheduling

3

Building Characteristics

4

Loads

1

Sc HDD

3

SP Heat:

70

HDD Avg:

4374

SP Cool:

70

CDD Avg:

1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number Geothermal ☐
School
County
School Street Address

City State Zip
Status of Survey

Age of School
Contact
E-mail
Phone
School Phone Number

Architect
Engineer
No. of Staff No. of Students
ADA Dates of School Year
Hours in School Day
Other Occupancy

Building Envelope:

Heated Space (ft2)
Cooled Space (ft2)
Wall Construction
Windows
Roof

Additional Comments:

HDD and CDD from Johnson Co. Loads set to 5 although less than 0.75 students/sq-ft.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)
Electric Demand (kW/yr)
Annual Electric Cost
Natural Gas Usage (ccf/yr)
Annual Natural Gas Cost
Propane Usage (gal/yr)
Annual Propane Cost
Pool Kitchen
Computers Vending Machines
Outdoor Lighting

Mechanical Systems:

Cost Type
Cooling Days WSHP with chiller, electric boiler for heat
Heating Days
Age
Scheduled Maintenance Description

Repairs or Failures Reported

Energy Saving Features

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number <input type="text" value="21"/>	Geothermal <input checked="" type="checkbox"/>	Age of School <input type="text" value="2001 (4 years)"/>	Architect <input type="text" value="Lucas/Schwering Architects"/>
School <input type="text" value="Eden Elementary"/>	Contact <input type="text" value="Landon Preece"/>	Engineer <input type="text" value="KTA Consulting Engineers"/>	
County <input type="text" value="Martin.Co"/>	E-mail <input type="text" value="lpreece@martin.k12.ky.us"/>	No. of Staff <input type="text" value="94"/>	No. of Students <input type="text" value="455"/>
School Street Address <input type="text" value="212 Eden Elementary Drive"/>	Phone <input type="text" value="606-298-3572"/>	ADA <input type="text" value="419"/>	Dates of School Year <input type="text" value="Aug-May"/>
City <input type="text" value="Inez"/>	State <input type="text" value="KY"/>	School Phone Number <input type="text" value="606-298-3471"/>	Hours in School Day <input type="text" value="8.5"/>
Zip <input type="text" value="41224"/>		Other Occupancy <input type="text" value=""/>	
Status of Survey <input type="text" value="in before 4/5/05"/>			

Building Envelope:

Heated Space (ft2)	<input type="text" value="58,520"/>
Cooled Space (ft2)	<input type="text" value="58,520"/>
Wall Construction	<input type="text" value="block"/>
Windows	<input type="text" value="thermal pane"/>
Roof	<input type="text" value="sloped roof"/>

Additional Comments:

Scheduling set to 3 although winter setpoint temperature is more than 68.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	<input type="text" value="720,984"/>
Electric Demand (kW/yr)	<input type="text" value="16,205.0"/>
Annual Electric Cost	<input type="text" value="\$47,816.03"/>
Natural Gas Usage (ccf/yr)	<input type="text" value="0"/>
Annual Natural Gas Cost	<input type="text" value="\$0.00"/>
Propane Usage (gal/yr)	<input type="text" value="0"/>
Annual Propane Cost	<input type="text" value="\$0.00"/>
Pool <input type="text" value="no"/>	Kitchen <input type="text" value="yes"/>
Computers <input type="text" value="108"/>	Vending Machines <input type="text" value="3"/>
Outdoor Lighting	<input type="text" value=""/>

Mechanical Systems:

Cost	<input type="text" value="\$1,060,787"/>	Type	<input type="text" value="GHP System"/>
Cooling Days	<input type="text" value="215"/>	Heating Days	<input type="text" value="150"/>
Age	<input type="text" value="4 years"/>		
Scheduled Maintenance Description <input type="text" value="Change air filters, lube pumps and motors, check temperature on loop system"/>			
Repairs or Failures Reported <input type="text" value="Compressors and fans burned out"/>			
Energy Saving Features <input type="text" value="Temperature controls, night setback temperature, make up air handlers"/>			

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	22	Geothermal	<input checked="" type="checkbox"/>	Age of School	1956, 1998 addition	Architect	Clotfelter/Samokar, PSC
School	Eubank Elementary	Contact	BJ Lawson, Energy Manager	Engineer	Clotfelter/Samokar, PSC		
County	Pulaski Co.	E-mail	blawson@pulaski.net	No. of Staff	47	No. of Students	291
School Street Address	285 W. Hwy 70	Phone	606-679-1123 ext 291	ADA	275	Dates of School Year	Aug 1-June 15
City	Eubank	State	KY	School Phone Number	606-379-5304	Hours in School Day	9.5
Zip	42567					Other Occupancy	Activities evenings, weekends
Status of Survey	in before 4/5//05						

Building Envelope:

Heated Space (ft2)	37,570
Cooled Space (ft2)	37,570
Wall Construction	block/brick
Windows	double pane
Roof	flat with some sloped

Additional Comments:

District has an energy manager. Loads set to 1 although has outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	554,477		
Electric Demand (kW/yr)	2,269.0		
Annual Electric Cost	\$32,755.00		
Natural Gas Usage (ccf/yr)	0		
Annual Natural Gas Cost	\$0.00		
Propane Usage (gal/yr)	0		
Annual Propane Cost	\$0.00		
Pool	No	Kitchen	Yes
Computers	115	Vending Machines	10
Outdoor Lighting	Parking lot, building security lights, football		

Mechanical Systems:

Cost	\$676,260	Type	GHP/rooftop AC
Cooling Days	182		
Heating Days	183		
Age	7 years		
Scheduled Maintenance Description			
Filter changes monthly, inspect belts and grease every 9-12 months			
Repairs or Failures Reported			
Change heat pump water every 9-12 months			
Energy Saving Features			
Economizers, central controls, gets energy audited monthly			

Scoring:

Scheduling

3

Building Characteristics

3

Loads

1

Sc HDD

3

SP Heat: 72-60

HDD Avg: 4358

SP Cool: 74-80

CDD Avg: 1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	23	Geothermal	<input checked="" type="checkbox"/>	Age of School	1959, 1998 addition	Architect	Clotfelder/Samokar, PSC
School	Nancy Elementary			Contact	BJ Lawson, Energy Manager	Engineer	Clotfelder/Samokar, PSC
County	Pulaski Co.			E-mail	blawson@pulaski.net		
School Street Address	240 Hwy 196			Phone	606-679-1123 ext 291	No. of Staff	54
				School Phone Number	606-636-6338	No. of Students	349
City	Nancy	State	KY			ADA	333
Zip	42544					Dates of School Year	Aug 1-June15
Status of Survey	in (3/28/05)						
						Hours in School Day	9.5
						Other Occupancy	Activities evenings, weekends

Building Envelope:

Heated Space (ft2)	42,044
Cooled Space (ft2)	42,044
Wall Construction	block and brick
Windows	double pane
Roof	flat

Additional Comments:

District has an energy manager

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	608,201
Electric Demand (kW/yr)	3,302.0
Annual Electric Cost	\$35,667.00
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	130
Vending Machines	8
Outdoor Lighting	parking lot/bldg security lights

Mechanical Systems:

Cost	\$756,792	Type	
Cooling Days	182	Heating Days	183
Age	7		
Scheduled Maintenance Description			
Filter changes monthly, inspect belts and grease every 9-12 months			
Repairs or Failures Reported			
Change heat pump water every 9-12 months			
Energy Saving Features			
Economizers, central controls, gets energy audited monthly			

Scoring:

Scheduling	Building Characteristics	Loads	Sc HDD	SP Heat:	72-60	HDD Avg:	4358
5	3	3	3	SP Cool:	74-80	CDD Avg:	1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	24	Geothermal	<input checked="" type="checkbox"/>	Age of School	1962, renovation in 2001	Architect	Clotfelter/Samokar, PSC
School	Pulaski Elementary			Contact	BJ Lawson, Energy Manager	Engineer	Clotfelter/Samokar, PSC
County	Pulaski Co.			E-mail	blawson@pulaski.net		
School Street Address	107 W. University Drive			Phone	606-679-1123 ext 291	No. of Staff	85
				School Phone Number	606-678-4713	No. of Students	682
City	Somerset	State	KY			ADA	652
Zip	42503					Dates of School Year	Aug 1-June 15
Status of Survey	in 3/28					Hours in School Day	9.5
						Other Occupancy	Activities evenings, weekends

Building Envelope:

Heated Space (ft2)	61,678
Cooled Space (ft2)	61,678
Wall Construction	block, brick
Windows	double pane
Roof	flat, some sloped

Additional Comments:

District has an energy manager

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	788,721
Electric Demand (kW/yr)	3,965.0
Annual Electric Cost	\$34,229.00
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	250
Vending Machines	6
Outdoor Lighting	parking and building security lights

Mechanical Systems:

Cost	\$1,233,560	Type	
Cooling Days	182	GHP w/ two make-up air units	
Heating Days	183		
Age	4 years		
Scheduled Maintenance Description			
filter changes done monthly, inspect belts and grease every 6 months			
Repairs or Failures Reported			
Change heat pump water loops every 9 to 12 months			
Energy Saving Features			
Economizers, central controls, gets energy audited monthly			

Scoring:

Scheduling	Building Characteristics	Loads	Sc HDD	SP Heat:	72-60	HDD Avg:	4358
5	4	5	3	SP Cool:	74-80	CDD Avg:	1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	25	Geothermal	<input checked="" type="checkbox"/>	Age of School	1959, renovation 1998	Architect	Clotfelter/Samokar, PSC
School	Shopville Elementary			Contact	BJ Lawson, Energy Manager	Engineer	Clotfelter/Samokar, PSC
County	Pulaski Co.			E-mail	blawson@pulaski.net		
School Street Address	10 Shopville Rd			Phone	606-679-1123 ext 291	No. of Staff	56
				School Phone Number	606-274-4411	No. of Students	374
City	Somerset	State	KY	Zip	42503	ADA	356
Status of Survey	in before 4/5//05					Dates of School Year	Aug 1-June 15
						Hours in School Day	9.5
						Other Occupancy	Activities evenings, weekends

Building Envelope:

Heated Space (ft2)	47,906
Cooled Space (ft2)	47,906
Wall Construction	block/brick
Windows	double pane
Roof	flat with some sloped

Additional Comments:

District has an energy manager

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	670,201
Electric Demand (kW/yr)	3,324.0
Annual Electric Cost	\$39,102.00
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	
Annual Propane Cost	
Pool	No
Kitchen	Yes
Computers	140
Vending Machines	7
Outdoor Lighting	Parking lot, building security lights

Mechanical Systems:

Cost	\$862,308	Type	
Cooling Days	182	GHP/rooftop units 2 make-up air units	
Heating Days	183		
Age	7 years		
Scheduled Maintenance Description			
Filter changes monthly, inspect belts and grease every 9-12 months			
Repairs or Failures Reported			
Change heat pump water every 9-12 months			
Energy Saving Features			
Economizers, central controls, gets energy audited monthly			

Scoring:

Scheduling	Building Characteristics	Loads	Sc HDD	SP Heat:	72-60	HDD Avg:	4358
5	4	3	3	SP Cool:	74-80	CDD Avg:	1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	26	Geothermal	<input checked="" type="checkbox"/>	Age of School	1957, 1998 renovation	Architect	Clotfelter/Samokar, PSC
School	Woodstock Elementary			Contact	BJ Lawson, Energy Manager	Engineer	Clotfelter/Samokar, PSC
County	Pulaski Co.			E-mail	blawson@pulaski.net		
School Street Address				Phone	606-679-1123 ext 291	No. of Staff	31
				School Phone Number	606-379-2151	No. of Students	150
City		State				ADA	142
Zip						Dates of School Year	Aug 1-June 15
Status of Survey	in before 4/5//05						
						Hours in School Day	9.5
						Other Occupancy	Activities evenings, weekends

Building Envelope:

Heated Space (ft2)	24,133
Cooled Space (ft2)	24,133
Wall Construction	block brick
Windows	double pane
Roof	flat

Additional Comments:

District has an energy manager. Loads set to 1 although has outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	367,487
Electric Demand (kW/yr)	1,494.0
Annual Electric Cost	\$21,936.00
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	
Annual Propane Cost	
Pool	no
Kitchen	yes
Computers	80
Vending Machines	6
Outdoor Lighting	parking/building security lights

Mechanical Systems:

Cost	\$434,398	Type	
Cooling Days	216	Heating Days	150
Age	7 years	Scheduled Maintenance Description	Filter changes monthly, inspect belts and grease every 9-12 months
Repairs or Failures Reported	Change heat pump water every 9-12 months		
Energy Saving Features	Economizers, central controls, gets energy audited monthly		

Scoring:

Scheduling

5

Building Characteristics

4

Loads

1

Sc HDD

3

SP Heat: 72-60

HDD Avg: 4358

SP Cool: 74-80

CDD Avg: 1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	27	Geothermal	<input checked="" type="checkbox"/>	Age of School	2002 (3 years)	Architect	Nolan and Nolan
School	Painted Stone Elementary			Contact	Doug Boston	Engineer	Nolan and Nolan
County	Shelby Co.			E-mail	dboston@shelby.k12.ky.us		
School Street Address	150 Warriors Way			Phone	502-647-0209	No. of Staff	80
				School Phone Number	502-647-4505	No. of Students	602
City	Shelbyville	State	KY			ADA	580
Zip	40065					Dates of School Year	8-11 to 5-24
Status of Survey	in 5/05						
						Hours in School Day	12
						Other Occupancy	

Building Envelope:

Heated Space (ft2)	76,000
Cooled Space (ft2)	76,000
Wall Construction	block w brick veneer
Windows	double pane insulated
Roof	metal sloped with 4.5 in. rigid insul.

Additional Comments:

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	2,121,960
Electric Demand (kW/yr)	5,281.0
Annual Electric Cost	\$88,977.60
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	81
Vending Machines	3
Outdoor Lighting	parking lot and site lighting

Mechanical Systems:

Cost	\$1,596,000	Type	
Cooling Days	183	GHP 78 classroom heat pump units	
Heating Days	182		
Age	3 years		
Scheduled Maintenance Description			
filters, every three months (classrooms)			
Repairs or Failures Reported			
All fan motors replaced on classroom heat pumps, several heat pump compressors			
Energy Saving Features			
Automated building controls, timer for site-lighting			

Scoring:

Scheduling

5

Building Characteristics

1

Loads

3

Sc HDD

5

SP Heat:

72

HDD Avg:

5219

SP Cool:

72

CDD Avg:

1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	28	Geothermal	<input checked="" type="checkbox"/>	Age of School	'49, '79, '94, '96, '98	Architect	SCB Architects
School	Richardsville Elementary			Contact	Charles Rector	Engineer	Kerr Greulich
County	Warren Co.			E-mail	crector@warren.k12.ky.us		
School Street Address	1775 Richardsville Rd			Phone	(270) 842-0702	No. of Staff	69
				School Phone Number	270-777-3232	No. of Students	472
City	Bowling Green	State	KY			ADA	443
Zip	42101					Dates of School Year	Aug 5-May 20
Status of Survey	in 4/26						

Building Envelope:

Heated Space (ft2)	45,306
Cooled Space (ft2)	45,306
Wall Construction	Brick/Block
Windows	Single Pane/Thermal Pane
Roof	Sloped single ply R-19

Additional Comments:

25 printer/copiers, 44 monitors.
Assuming setbacks in place due to EMS installed. Loads set to 3 although has no outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	827,400
Electric Demand (kW/yr)	
Annual Electric Cost	\$70,014.88
Natural Gas Usage (ccf/yr)	0
Annual Natural Gas Cost	\$0.00
Propane Usage (gal/yr)	0
Annual Propane Cost	\$0.00
Pool	no
Kitchen	yes
Computers	136
Vending Machines	8
Outdoor Lighting	

Mechanical Systems:

Cost		Type	Geothermal since 1998
Cooling Days			
Heating Days			
Age	7 years		
Scheduled Maintenance Description			
Repairs or Failures Reported			
None			
Energy Saving Features			
Automated Logic, EMS, Energy Ed manager on staff			

Scoring:

Scheduling	Building Characteristics	Loads	Sc HDD	SP Heat:	HDD Avg:
1	5	3	1		4243
				SP Cool:	CDD Avg:
					1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	29	Geothermal	<input checked="" type="checkbox"/>	Age of School	1952, 98, 02	Architect	Sherman Carter Barnhart Architects
School	Richpond Elementary			Contact	Charles Rector	Engineer	NJC Engineering
County	Warren Co.			E-mail	crector@warren.k12.ky.us	No. of Staff	87
School Street Address	530 Rich Pond Rd.			Phone	970-842-0702	No. of Students	733
City	Bowling Green	State	KY	School Phone Number	270-781-9627	ADA	696
Zip	42104	Dates of School Year	Aug 5 - May 2				
Status of Survey	in in april						
Hours in School Day	7						
Other Occupancy							

Building Envelope:

Heated Space (ft2)	58,622
Cooled Space (ft2)	58,622
Wall Construction	Block Brick
Windows	orig. single pane, addition ther
Roof	R19

Additional Comments:

25 copiers. Assuming setbacks in place due to EMS installed. Loads set to 5 although has no outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)	745,280		
Electric Demand (kW/yr)			
Annual Electric Cost	\$70,843.07		
Natural Gas Usage (ccf/yr)	0		
Annual Natural Gas Cost	\$0.00		
Propane Usage (gal/yr)	0		
Annual Propane Cost	\$0.00		
Pool	no	Kitchen	yes
Computers	142	Vending Machines	8
Outdoor Lighting			

Mechanical Systems:

Cost		Type	
Cooling Days		Heating Days	
Age		Scheduled Maintenance Description	
Repairs or Failures Reported	None		
Energy Saving Features	Automated Logic, EMS, Energy Ed manager on staff		

Scoring:

Scheduling

1

Building Characteristics

5

Loads

5

Sc HDD

1

SP Heat:

HDD Avg:

4243

SP Cool:

CDD Avg:

1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number Geothermal ☐
School
County
School Street Address

City State Zip
Status of Survey

Age of School
Contact
E-mail
Phone
School Phone Number

Architect
Engineer
No. of Staff No. of Students
ADA Dates of School Year
Hours in School Day
Other Occupancy

Building Envelope:

Heated Space (ft2)
Cooled Space (ft2)
Wall Construction
Windows
Roof

Additional Comments:

59 more monitors and 47 printers/copiers. Assuming setbacks in place due to EMS installed. Loads set to 3 although ancillary equipment is more than 150 and has no outdoor lighting.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr)
Electric Demand (kW/yr)
Annual Electric Cost
Natural Gas Usage (ccf/yr)
Annual Natural Gas Cost
Propane Usage (gal/yr)
Annual Propane Cost
Pool Kitchen
Computers Vending Machines
Outdoor Lighting

Mechanical Systems:

Cost Type
Cooling Days
Heating Days
Age
Scheduled Maintenance Description

Repairs or Failures Reported

Energy Saving Features

Scoring:

Scheduling

Building Characteristics

Loads

Sc HDD

SP Heat:

HDD Avg:

SP Cool:

CDD Avg:

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.

Number	31	Geothermal	<input type="checkbox"/>	Age of School	1998 (6 years)	Architect	Lucas/Schwering
School	No. Washington Elementary			Contact	John Reinle	Engineer	KTA, John Carman and Ass., Poage
County	Washington Co.			E-mail	jreinle@washington.k12.ky.us	No. of Staff	81
School Street Address	5658 Highway 433			Phone	859-336-5470	No. of Students	499
City	Willisburg	State	KY	School Phone Number	859-336-5490	ADA	480
Zip	40078	Dates of School Year					
Status of Survey	in before 4/5/05						
Hours in School Day	9.5						
Other Occupancy							

Building Envelope:

Heated Space (ft2) 60,125

Cooled Space (ft2) 60,125

Wall Construction block

Windows double pane

Roof flat, rubber with rock ballast, 4in. Ins

Additional Comments:

HDD and CCD from Nelson Co. Loads set to 3 although ancillary equipment is more than 150.

Energy (July 2003 to June 2004):

Electric Usage (kWh/yr) 1,111,606

Electric Demand (kW/yr)

Annual Electric Cost \$71,798.58

Natural Gas Usage (ccf/yr) 0

Annual Natural Gas Cost \$0.00

Propane Usage (gal/yr) 0

Annual Propane Cost \$0.00

Pool No Kitchen Yes

Computers 150 Vending Machines 2

Outdoor Lighting limited outside lighting

Mechanical Systems:

Cost \$1,132,755 Type

Cooling Days 216 Chiller and rooftop AC, heat pump and hot water heat

Heating Days 150

Age 6 years

Scheduled Maintenance Description
Quarterly PMC+filter change, done by outside company

Repairs or Failures Reported
Trouble with air handler, corrected by contractor

Energy Saving Features
Economizer w/ automated controls

Scoring:

Scheduling

5

Building Characteristics

1

Loads

3

Sc HDD

3

SP Heat: 74

HDD Avg: 4497

SP Cool: 70

CDD Avg: 1

* These scores are based on a 1 - 5 scale. See Scoring Method in report, page 13-14.